Note to reader: Page references provided in the Notice of Opportunity to Comment for the Mission Revised Preliminary EA may be off by one number in this excerpt from the full document.

Chapter 3: Existing Condition and Environmental Consequences

3.1 Introduction

This chapter presents information about current resource conditions, and the direct, indirect and cumulative effects of implementing the proposed action. The information presented in this chapter summarizes and cites the specialists' reports that are found in the project record. Full versions of these specialists' reports are available at the Methow Valley Ranger District office in Winthrop, Washington.

Each resource area discloses the direct, indirect and cumulative effects for that resource area. Direct effects are those caused by the action, occurring at the same time and place. Indirect effects are caused by the action with subsequent effects later in time or further removed in distance, but are still reasonably predicted. Cumulative effects are the incremental effects of the Mission Restoration proposed action, when considered with the overall effects of past, present, and reasonably foreseeable future actions.

3.1.1. Past, Present, and Reasonably Foreseeable Future Actions

The interdisciplinary team (IDT) identified past, present, and reasonably foreseeable future actions that might have cumulative impacts with the proposed actions early in the analysis process. Those actions are described below. Each resource area considered different mixes of these actions, depending on the cumulative effects boundary for the resource area and the resource affected. Only those past, present and reasonably foreseeable actions that overlap the geographic analysis area boundary for each particular resource are considered, and only if those other actions have or are expected to have overlapping effects with the Mission Restoration Project. Some past projects may still be having effects on one resource, but not another.

3.1.1.1 Past Actions

In order to understand the contribution of past actions to the cumulative effects of the proposed action, this analysis relies on current environmental conditions as a proxy for the impacts of past action. This is because existing conditions reflect the aggregate impact of all prior human actions on natural events that have affected the environment and might contribute to cumulative effects.

The cumulative effects analyses do not attempt to quantify the effects of past human actions by adding up all prior actions on an action-by-action basis. There are several reasons for not taking this approach. First, a catalog and analysis of all past actions would be impractical to compile and unduly costly to obtain. Current conditions have been impacted by innumerable actions over the last century and beyond, and trying to isolate the individual actions that continue to have residual impacts would be nearly impossible. Second, providing the details of past actions on an individual basis would not be useful to predict the cumulative effects of the

proposed action. In fact, focusing on individual actions would be less accurate than looking at existing conditions, because there is limited information on the environmental impacts of individual past actions, and one cannot reasonably identify each and every action over the last century that has contributed to current conditions. Additionally, focusing on the impacts of past human actions risks ignoring the important residual effects of past natural events that may contribute to cumulative effects as much as human actions. By looking at current conditions, residual effects of past human actions and natural events are captured, regardless of which particular action or event contributed those effects. Thirdly, public scoping for this project did not identify and public interest of need for detailed information on individual past actions. Finally, the Council on Environmental Quality (CEQ) issued an interpretive memorandum on June 24, 2005 regarding analysis of past actions, which states, " agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions."

The cumulative effects analysis in this EA is also consistent with Forest Service National Environmental Policy Act Regulations (36 CFS 220.4(f)) July 24, 2008, which state in part: "CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions."

For these reasons, the analysis of past actions in the cumulative effects analysis is based on current environmental conditions.

Past and on-going actions affecting resources may be described as part of the existing condition information for specific resources later in this chapter. A summary of certain types of past actions known to have occurred in the project area is available in the project record.

3.1.1.2 Present and On-going Actions

Transportation System: Maintenance of system roads continues and includes danger tree removal along roads when needed.

Livestock Grazing: A portion of the Lookout Mountain grazing allotment is located within the project area. An Environmental Assessment and decision for the revision of the Allotment Management Plan (AMP) for this allotment was completed in 2011. Livestock movement and grazing management is facilitated by utilizing fences, water developments, corrals, and stock driveways. Range management practices such as riding; adjusting intensity, timing and duration of use; proper salting, and maintaining water developments and fences would continue to be implemented through annual coordination between the District Rangeland Management Specialists and the permittee (rancher) to meet riparian objectives and to obtain a more uniform distribution of use on the allotment.

Invasive Plant Treatments: Weed populations continue to be treated annually by spot-spraying with herbicide, hand-pulling, or bio-control agents. The 2000 Noxious Weed Integrated Weed Management EA covers portions of the project area.

Recreation: Activities include: campground management, including hazard tree removal, road and other infrastructure maintenance, snowmobiling and snowmobile trail grooming, hunting,

fishing, camping in dispersed sites and campgrounds, firewood gathering, Off-Highway Vehicle (OHV) use, pleasure driving, mountain and road biking, hiking, and horseback riding.

3.1.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions are those proposed and scheduled for planning and/or implementation. Future projects not covered by a decision at this time will be thoroughly analyzed and documented in separate environmental documents. The interdisciplinary team made assumptions about the environmental effects of the future projects, because the effects of many of the projects are unknown at this time. The basic assumption for every project is that it will meet amended Forest Plan standards and guidelines. These assumed effects were used in the cumulative effects analyses at the end of each resource section. The reasonably foreseeable future actions used in this analysis are listed below:

Transportation System and Travel Management: Maintenance of system roads will continue and will include danger tree removal when needed along roads. The Forest is conducting an environmental analysis for travel management planning that will designate motorized public access routes in the project area; a decision on this analysis is expected in 2017. Within the Mission Restoration project area, the proposed alternative would not include new motorized travel routes, motorized trails, or authorization of unlicensed vehicles on open roads.

Livestock Grazing: Grazing will continue on the Lookout Mountain allotment. Active rangeland management would continue to be implemented through annual coordination between the District Rangeland Management Specialists and the permittee (rancher).

Invasive Plant Treatments: Integrated weed management (IWM) would continue to reduce or eliminate new invader weed infestations with emphasis on early detection of new infestations, rapid treatment response, and prompt revegetation. The combination of herbicide, biological, and manual treatments would be conducted by the District Weed program with herbicide treatments authorized under the 2000 Okanogan National Forest Integrated Weed Management EA Decision Notices. The Forest is finalizing an environmental analysis (the Forest-wide Site-Specific Invasive Plants Environmental Impact Statement) with a decision expected in 2017. This EIS will provide for invasive plant treatments in the project area and will supersede previous decisions.

Recreation: Recreational activities are expected to occur as described in Present actions with the exception of OHV use, which would be altered according to the outcome of the travel management planning project decision.

3.2 Impact Terms Defined

Effects were evaluated for each retained impact topic in terms of type, context, duration, and intensity. Type describes whether impacts are beneficial or adverse:

> *Beneficial*: A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.

Adverse: A change that moves the resource away from a desired condition or detracts from its appearance or condition.

Context describes the area or location in which the impact will occur, such as site-specific, local, regional, or even broader.

Duration describes the length of time an effect will occur, either short-term or long-term:

Short-term impacts generally last only during construction, and the resources resume their pre-construction conditions following construction.

Long-term impacts last beyond the construction period and resources may not return to pre-construction conditions for a longer period of time.

Intensity describes the degree, level, or strength of an impact. For this analysis, intensity is categorized into negligible, minor, moderate, and major. Intensity definitions are provided for each impact topic analyzed in this environmental assessment.

3.3 Water Resources

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Water Resources Report by G. Shull and R. L. George (2016), available in the project record. Reference information is contained in the full specialist report.

3.3.1 Methodology

The resource elements, indicators, and measures used to analyze and compare potential effects of the Mission Restoration on hydrologic and aquatic resources are shown in Figure 12. Indicators and measures address the purpose and need and key internal issues raised during project planning.

Figure 12. Water resource elements, indicators, and measures.

Resource Element	Indicator	Measure	Purpose & Need or Key Issue	Source
Water Quality (Sediment)	• Road density • Road drainage network increase • Riparian road density • Road-stream crossing density • Groundcover	• Number of Catchment Rankings Lowered • Acres of bare soil	P&N #1	NWFP S&G 1994; UCSRP 2007; WCF 2010

Resource Element	Indicator	Measure	Purpose & Need or Key Issue	Source
Water Quantity (base flow)	• Beaver habitat	• Number of beaver habitat enhancement sites	P&N #1	NWFP S&G 1994; UCSRP 2007; WCF 2010
Aquatic Habitat	• Stream channel complexity • Fish distribution	• Miles of stream restored with coarse woody debris • Miles of stream accessible to fish • Number of aquatic organism passage pipes installed	P&N #1	NWFP S&G 1994; UCSRP 2007; WCF 2010

Scale of Analysis and Watershed Hierarchy: The 25,500-acre Buttermilk and 23,500-acre Libby Creek sub-watersheds are within the Twisp River and Lower Methow River watersheds in the Methow River sub-basin. The watershed hierarchy of the project area sub-watersheds are shown in Figure 13. The hydrologic and aquatic analysis area for the Mission Restoration Project is the Buttermilk and Libby Creek sub-watersheds. Direct, indirect, and cumulative effects are analyzed at the scale of all lands in these sub-watersheds. The temporal scale for effects analysis is 30 years--the time it is estimated to take for morphological improvements in stream channel variables from upland treatments to be measureable.

Figure 13. Watershed hierarchy of the Mission Project area.

Basin	Sub-basin	Watershed	Sub-watershed
Upper Columbia 170200	Methow River 17020008	Twisp River 1702000805 Lower Methow River 1702000807	Buttermilk Creek 170200080506 Libby Creek170200080701

Roads/Watershed Assessment Method: The extensive road network is one of the primary drivers impairing current watershed and aquatic ecosystem function. To assess current road conditions and their potential impacts on watershed and aquatic habitat conditions, a GIS-based model called NetMap (Benda et al. 2007) was used with a digital terrain database and landscape attributes relating to erosion hazards to evaluate and prioritize roads that pose varying levels of risk to hydrologic and aquatic resources. NetMap identified each road segments as being at low, moderate, or high risk for erosion or other effects to aquatic resources based on these four primary factors:

- Shallow landslide potential associated with roads

- Roads that intersect channel floodplains and Endangered Species Act (ESA) critical habitat floodplains
- Erosion risk related to road density upslope from stream reaches
- The potential for roads to divert streams

In addition to this process, a road assessment procedure developed for the Draft Okanogan-Wenatchee Whole Watershed Restoration Procedures (WWRP; USDA 2015) was used to identify potential road-stream impacts and roads or groups of roads to remove or hydrologically close to benefit hydrologic processes.

Since land management activities affecting watershed function are generally not distributed evenly across watersheds, the roads analysis looked at road-stream interactions at a smaller catchment scale to identify where road-stream impacts are likely to be high. Development of 300-1,500 acre smaller catchments (hereafter referred to as catchments) allowed for greater focus in areas that have the highest degree of road impairment. Proposed treatments were determined based on analysis of limiting factors to watershed function. Eighteen catchments were delineated in the Buttermilk and twenty six in the Libby Creek sub-watersheds.

This procedure incorporates geomorphic and ecological principles associated with road impacts in existing watershed and aquatic resource restoration planning mechanisms at varying spatial scales (i.e. Robinson et al 2010; Rosgen 2006). The physical road indicators assessed include road density, increase in drainage network (artificial streams) from the road system, riparian road density (density of roads within 300 feet of streams), and the number of road crossings per stream mile. These indicators are used to identify where potential road impacts are high and as a proxy to measure the degree of impacts or impairment roads pose to watershed and aquatic resources. High, moderate, and low rankings were assigned to different the indicators based on scientific literature related to road-watershed and aquatic habitat impacts. A rating for each catchment was calculated and assigned a color value based on potential road-stream interaction magnitude and to some degree, a level of departure from historic conditions. Figure 14 displays the metrics, catchment ranking thresholds, catchment rating, and associated color code that affect the watersheds in the project area at the catchment scale.

Figure 14. Ranking of physical variables

Metric	Catchment Ranking Criteria	Catchment Road-Stream Interaction	Catchment Color Assignment
Catchment Road density	0-1 mi/mi^2	Low	Green
	1-2.4 mi/mi^2	Moderate	Yellow
	>2.4 mi^2	High	Red
Increase in drainage network from the road system	0-0.10	Low	Green
	0.11-0.30	Moderate	Yellow
	>0.30	High	Red
Riparian Road Density	0-1 mi/mi^2	Low	Green

Metric	Catchment Ranking Criteria	Catchment Road-Stream Interaction	Catchment Color Assignment
	1-2.4 mi/mi^2	Moderate	Yellow
	>2.4 mi^2	High	Red
Road crossings per stream mile	0-1	Low	Green
	1-3	Moderate	Yellow
	>3	High	Red

The following indicators were analyzed using the methods explained above:

Resource Indicator: Road Density
Road density can be a measure of hydrologic and aquatic impacts at a watershed or sub-watershed scale (Lee et al. 1997; McCaffery et al. 2007). Road densities of <1 mi/mi^2 are considered low enough to support proper watershed and aquatic function (USDI 1998). Road densities of 1 to 2.4 mi/mi^2 are considered functional at risk, and road densities >2.4 mi/mi^2 are considered not functional (Lee et al. 1997). This analysis acknowledges road densities that are aptly used at assessing hydrologic processes and aquatic habitat conditions at the watershed or sub-watershed scale and not at the smaller, catchment scale. As such, the road density was used for identifying where potential road-stream interactions are high and not to assess catchment condition.

Using GIS, road density was calculated at the catchment scale using all road miles (Maintenance Level 1-5 and unauthorized roads) divided by square miles of land within each catchment. For this analysis, changes in road density was compared between the existing condition and the proposed action alternatives. Changes in road density were discussed with the assumption that reduced road densities would be a beneficial effect to hydrologic and aquatic resources at the sub-watershed scale.

Resource Indicator: Increase in road drainage network
Roads can increase the stream network by intercepting subsurface flow and transporting surface water on the road surface, ditch lines, and down cross-drain culverts (artificial streams). Hydrologically connected roads increase the rate watersheds drain and increase the magnitude and frequency of peak flows, particularly for small floods (Wemple et al. 1996). Potential effects can range from localized sites (plugged culverts, localized landslides, etc.) to broad watershed scale effects, such altering timing of peak flows.

Increases in drainage network from the road system was calculated using miles of road that are hydrologically connected to the stream network. Specifically, this indicator is the ratio of the length of all the road segments that drain within 300' of the streams to the total length of streams in the catchment. This metric provides a useful proxy for degree of hydrologic impact from the road system.

For this analysis, changes in the road drainage network was compared between the existing condition and the proposed action alternatives. Changes in road drainage network caused by the proposed road treatments are discussed in context of how they changed indicators at the catchment scale and would affect hydrologic and aquatic habitat resources at the sub-watershed scale.

Resource Indicator: Riparian Road Density
Though roads typically provide a range of public benefits, their construction and presence can alter watershed-scale hydrologic and ecological processes as previously described. The WWRP calculates the density of road segments within 300 feet of streams (called "riparian roads" in this analysis) as proxy for road-stream impacts such as sediment sources, loss of instream wood recruitment, and channel constriction. Riparian road density was calculated by the ratio of miles of roads within 300 feet of streams to the square miles of area within 300 feet of streams, by catchment. For this analysis, riparian road density was compared between the existing condition and the proposed action alternatives. A limitation in this indicator is that while it estimates the density of roads within Riparian Reserves (RRs), it does not account for amount of roads in the catchment; a catchment with a low overall road density could still have a high riparian road density, which would inaccurately assign the risk factors. To compensate for this limitation, this analysis averages catchment road density and riparian road density together to identify where both catchment road density and riparian road density are moderate or high. Changes in road density caused by proposed road treatments are discussed in context of how treatments would change indicators at the catchment scale and subsequent effects to hydrologic and aquatic resources at the sub-watershed scale.

Resource Indicator: Stream Crossings per Mile
The stream crossings per mile metric was calculated as the total stream crossings (fords, culverts, bridges) within each catchment by the total miles of streams. For the project effects analysis, stream crossing density was compared between the existing condition and the proposed action alternatives. Changes in stream crossing density from the proposed road treatments were discussed in context of how it changed the indicator at the catchment scale and would change hydrologic and aquatic resource conditions at the sub-watershed scale.

Aquatic Habitat and Species Assessment: In 2010, all National Forests implemented the Watershed Condition Framework (WCF) process, which is a rapid evaluation process that assess sub-watershed (Libby Creek and Buttermilk Creek) conditions based on land use, roads is similar in intent to that of Watershed Analysis (NWFP 1994). WCF uses an interdisciplinary approach to characterize the health and condition of sub-watersheds on NFS lands. Watershed condition is determined based on the health of hydrologic and soil function in the watershed indicated by physical (water quality and quantity, in-stream habitat, soil productivity, roads and trails, etc.) and biological characteristics (populations and conditions of desired fisheries and impacts of non-native species).

In addition to the WCF process, project biologists and hydrologists compiled information on aquatic habitat, riparian condition, and aquatic species distribution from a variety of sources including GIS data and previous Forest Service and WA DFW studies. Forest Service Level II stream surveys were conducted on the project area between 2010 and 2011 (USDA 2010; 2011).

The following indicators were analyzed using data from the aquatic habitat and species assessment data:

Resource Indicator: Ground Cover
Effective groundcover describes rock, living and dead herbaceous and woody materials in contact with the ground >3/4" in diameter that would protect the soil surface from erosion (Soil Management Handbook, USDA, 1992).

Changes in ground cover are analyzed by using Forest corporate and project spatial (GIS) data to estimate how much bare soil would be created (in acres) by management activities such as prescribed burning, temporary road construction (including unauthorized roads), and landing construction. Changes in bare soil acres are described in terms of effects on surface erosion and sediment delivery to the stream network.

Resource Indicator: Beaver Habitat
Anecdotal evidence indicates that beavers historically lived in the project area in both sub-watersheds (USDA 1995). Studies of similar habitats indicate that beavers create stream systems with slow, deep water and floodplain wetlands that play an important role diversifying stream and riparian habitat and providing water storage to supplement summer base flows. Beaver habitat enhancement sites have been identified in the project area in coordination with the ongoing beaver release program conducted by Washington State Department of Fish and Wildlife (WA DFW). Sites were selected based on exhibiting suitable gradient, presence of surface water and an identifiable stream channel, availability of forage and dam building materials, and potential for long-term success and restoration. For this analysis, each beaver habitat enhancement site would be a measure for assessing changes in natural water storage and water quantity at the sub-watershed scale.

Resource Indicator: Stream Channel Complexity
Large wood is important for reducing river energy, forming pools, and adding overall habitat complexity. The desired density of wood present in a stream is 105 to 270 pieces/mile of wood greater than 6 inches diameter along with 2-5 pieces/mile of larger wood greater than 18 inches and 35 feet long. To identify the existing instream wood quantities, aquatic habitat inventory data collected during Level 2 stream surveys in 2010 and 2011 were used to identify existing instream wood quantities (USDA 2010 and 2011b).

Resource Indicator: Fish Distribution
Fish in the project area include resident, anadromous, and Columbia Basin migratory species. Restoring and maintaining habitat connectivity is a high priority, cost-effective approach to protecting and restoring fish populations because it can increase habitat diversity and

population resilience and reduce effects of climate change-induced reductions in stream flow and increases in temperature.

Proposed treatments would improve habitat connectivity by replacing road culverts that partially or fully block fish passage with aquatic organism passage pipes (AOPs) to provide full passage to all fish life stages as well as to all other riparian dependent species. The unit of measure for assessing the changes to fish distribution will be the number of blocking culverts replaced with AOPs and miles of habitat with new or improved access.

3.3.2 Intensity Level Definitions

Type of Effect for Water Resources:

- Beneficial—Moves the system to or towards desired conditions and fish abundance improves or maintains robust local populations.
- Adverse—Moves the system outside of or away from the desired conditions and fish abundance improves or fish abundance improves or maintains robust local populations.

Duration of Effect for Water Resources:

- Short-term—an effect that would not be detectable within a short amount of time, generally within hours to a few weeks after the proposed activity has been carried out.
- Long-term—a change in a resource that will not return to its condition prior to the activity for the foreseeable future.

Intensity of Effect for Water Resources:

- Negligible: A change that would be so small as to be undetectable and without measurable or perceptible consequences to aquatic or hydrologic resources.
- Minor: A noticeable change that would cause detectable effects on aquatic or hydrologic resources, but would be small, localized, and inconsequential.
- Moderate: A noticeable change that would cause readily apparent, measurable, and localized effects to aquatic or hydrologic resources. Measurable effects could include substantial sediment delivery, the removal of large amounts of riparian trees, or the reduction of multiple stream crossings in drainage area. Mitigation measures would help off-set adverse effects.
- Major: A noticeable change to a physical resource that would be measurable and result in a highly adverse or beneficial impact that was readily apparent, measurable, intense, and felt on a regional scale. Substantial watershed features would be removed or the physical properties considerably altered. Mitigation measures proposed to offset adverse effects would be extensive and success would not be assured.3.3.3 Affected Environment

The Mission Project area encompasses approximately 50,200 acres within the Twisp River and Lower Methow River watersheds. The project area includes the lower portions of the Buttermilk Creek and Libby Creek sub-watersheds, which are approximately 23,500 and 25,500 acres in size, respectively (see Figure 15). The project boundaries correspond to watershed boundaries except for a small piece near the bottom of Buttermilk Creek that lies within the Mainstem Lower

Twisp River sub-watershed. Activities in this area are minor with no effects to hydrologic or aquatic resources and will not be discussed further. There are about 30 miles of perennial streams and approximately 14 miles of intermittent streams within the project area boundary.

Past management practices, including fire suppression, changed forest vegetation structure, overstory and understory species composition, and spatial patterns in comparison to historical conditions in riparian areas within the project area. These conditions also make riparian areas more susceptible to uncharacteristic harmful effects caused by wildfire.

Figure 15. Project watersheds by 10th and 12th Field HUC

HUC	HUC name	Acres	% of HUC5 area	Project planning area acres	% of HUC5/6 area
170200080507	Buttermilk Creek	23,500	99	10,900	~46
170200080701	Libby Creek	25,500	92	22,670	~89

Buttermilk Creek Sub-watershed Description: The headwaters originate within alpine cirques in the Lake Chelan-Sawtooth Wilderness at elevations of 7,000'-8,600'. Both the West and East forks of Buttermilk Creek flow for approximately nine miles before joining at river mile (RM) 2.6 and provide the majority of stream flow in the watershed. Downstream from this confluence, Buttermilk Creek flows through a steep canyon to join the Twisp River at RM 12. Perennial tributaries in the watershed include Black Pine Creek, which flows into the East Fork approximately 0.5 miles upstream of the forks' confluence. Several other intermittent streams enter into the West and East Forks and mainstem of Buttermilk Creek.

Almost all of the land in this drainage (99%) is managed by the Okanogan-Wenatchee National Forest. Much of the Twisp Watershed, including Buttermilk, is a Tier 1 key watershed identified under the NWFP as important in contributing to the conservation of anadromous salmonids, bull trout, and other resident fish species. About 12,200 acres of Buttermilk (about 52%) is within the Lake Chelan-Sawtooth Wilderness. The remaining ~11,300 acres lie within multiple-use management designations. A watershed analysis was completed in 1995 (USDA 1995a).

Libby Creek Sub-watershed Description: The headwaters of Libby Creek originate in alpine cirques and several lakes within the Lake Chelan-Sawtooth Wilderness at elevations of 6,800'-8,400'. Libby Creek mainstem is formed by the confluence of its two primary forks, the North Fork and South Fork, at RM 7.2, and these two tributaries contribute approximately 60% of stream flow to the mainstem (USFS 1999). Libby Creek flows in an easterly direction for approximately 14 miles to its confluence with the Methow River at RM 26, just downstream from the town of Carlton, at an elevation of 1,360'. Other tributaries to Libby Creek include Smith Canyon, Chicamun Canyon, Ben Canyon, Mission Creek, and Hornet Draw. These streams are mostly perennial but may flow intermittently in low water years and when water diversion volumes exceed instream flow. Several other intermittent creeks and draws also contribute to the instream flow especially during spring runoff.

Most of the land (92%) in this drainage is managed by the Okanogan-Wenatchee National Forest. About 3,000 acres of Libby (about 11%) is within the Lake Chelan-Sawtooth Wilderness. The remaining ~22,400 acres lie within multiple-use management designations. A watershed analysis was completed in 1995 (USDA 1995b).

Both the Buttermilk and Libby Creek sub-watersheds experienced decades of timber harvest, fire suppression, livestock grazing, firewood cutting, dispersed recreation impacts, and road construction with varying effects to aquatic and riparian resources. Implementation of the NWFP and listing fish species as Threatened or Endangered under the Endangered Species Act have substantially reduced activities and impacts within RRs.

Water Quality: The Forest Plan directs that the assessment of cumulative watershed effects to water quality be discussed in terms of the 10th field HUC watershed boundary. The Washington Department of Ecology Water Quality Assessment for Washington has sampling locations downstream from the proposed project area on the lower Twisp River and lower Methow River. There are no locations within the Twisp River Watershed (HUC 10) with a 303(d) Category 5 listing indicating impaired water quality. One 303(d) listed site exists in the Lower Methow River Watershed downstream of the project area. The Methow River near the confluence with the Columbia River is listed as impaired for pH and water temperature.

Washington State Water quality parameters specific to aquatic habitat that are most susceptible to change by thinning and prescribed fire treatments are turbidity, fine sediment, and temperature. This project would not impact these parameters where the sampling locations exist.

Fish Species and Habitat: The project analysis area contains habitat for fish species listed under the ESA, Regional Forester's Sensitive Species, Management Indicator Species (MIS), and species for which Essential Fish Habitat (EFH) has been designated under the Magnuson-Stevens Fishery Conservation and Management Act (**Figure 16**).

Figure 16. Project area fish species by listing designation

Designation	Species
ESA	Spring Chinook (Endangered), Summer Steelhead (Threatened), Bull Trout (Threatened)
R6 Sensitive	Westslope Cutthroat, Interior Redband Rainbow
MIS	Spring Chinook, Westslope Cutthroat, Interior Redband Rainbow, Steelhead, Bull Trout, Eastern Brook Trout
EFH	Chinook, Coho

Both the Buttermilk and Libby Creek drainages contain federally endangered Upper Columbia River Spring-run Chinook, threatened Upper Columbia River steelhead, and Columbia River bull trout. Buttermilk Creek is designated critical habitat for Spring Chinook, summer steelhead, and bull trout. Libby Creek is designated critical habitat for steelhead only. **Figure 17** displays the fish distribution and where critical habitat is designated.

Figure 17. Fish distribution in project area streams and designated critical habitat (CH)

Species	Spring Chinook		*O. mykiss*[1]		Bull trout		WSCT[1]	EBT[1]
	Distrib-ution[2]	Critical habitat	Distrib-ution[2]	Critical habitat	Distrib-ution[2]	Critical habitat	Distrib-ution[2]	Distrib-ution[2]
Buttermilk Cr.	1.1	1.1	2.5	2.4	2.5	2.5	2.5	- -
WF Buttermilk Cr.	- -	- -	2.9	- -	2.9	2.9	- -	- -
EF Buttermilk Cr.	- -	- -	5.5	- -	5.5	5.5	2.2	- -
Libby Creek	2.5.	- -	6.0	3.4	6.0[3]	- -	3.0	1.0[3]

[1] ***O.m.*** *– O. mykiss*, includes interior redband rainbow trout, steelhead and resident rainbow trout of unknown genetics; **WSCT** - westslope cutthroat; **EBT** – eastern brook trout

[1] Known distribution in miles.

[3] Based on limited data

Bull trout use West Fork and East Fork Buttermilk Creeks for spawning and rearing. The mainstem of Buttermilk Creek is used for foraging and migrating to and from spawning habitat. Limited bull trout use occurs in Libby Creek and there is no known spawning activity in this drainage. Steelhead salmon spawn and rear in Buttermilk and Libby Creeks. Juvenile spring chinook salmon use the lower portions of Buttermilk and Libby Creek for rearing.

Genetically pure interior redband rainbow trout (IRRT) are found in the Buttermilk Creek sub-watershed, with particularly good examples in West Fork Buttermilk Creek. The rainbow trout in Libby Creek has shown mixing with coastal rainbow trout strains as well as with cutthroat trout, suggesting they are not pure IRRT.

Westslope cutthroat trout (WSCT) are found within Buttermilk and North Fork Libby creeks (Proebstel et al. 1998). WDFW continues to stock many mountain lakes in the sub-basin with WSCT, which has artificially increased WSCT's range in the sub-basin. Cutthroat trout likely occur elsewhere in the analysis area, though genetic data are not available for all streams.

Eastern brook trout are present Libby Creek and the lower mile of North Fork Libby Creek. They are not native to the Columbia River Basin; however, as they are resident fish, they are considered a MIS species.

River Lamprey, Umatilla Dace, and Pygmy Whitefish are each Forest Service Regionally Sensitive Species located on the Okanogan-Wenatchee National Forest. None are known to occur in the Methow Sub-basin.

Aquatic habitat conditions within the project area are generally in fair condition with some properly functioning elements. Fish population levels in the analysis area are largely driven by actions that occur outside of the Methow Valley such as dams, commercial harvest, and hatcheries. Within the project area, habitat deficiencies include low base flows, low instream wood levels, excessive summer water temperatures (Libby Creek), elevated fine sediment in fish bearing tributaries, and habitat loss on in some private lands in the lower Buttermilk Creek, and Libby Creek drainages.

Salmon and trout are sensitive to accumulations of fine sediment in spawning grounds and juvenile rearing habitat. Excessive fine sediments in spawning gravels prevent flow of clean, oxygenated water through redds, which is important for providing sufficient oxygen to embryos and removing feces wastes (Meehan 1991; Goetz 1989). Excessive sedimentation rates can widen channels, while sediment deposition can disconnect side-channel habitat and reduce depth and quality of pool habitat, which reduces the availability of off-channel rearing habitat for juveniles during spring peak flows.

Forest Plan Forest-wide Standard 3-3 states that fine sediment levels in spawning areas should not exceed 20% for the <1mm size class (USDA 1989). The Fisheries Matrix of Pathway Indicators, or MPI, defines fine sediment levels of spawning habitat as Properly Functioning (PF) when particles <0.85 mm are less than 12%; Functioning At Risk (FAR) when these levels are 12-17%; and Not Functioning (NF) when these levels are greater than 17% (USDA et al. 2004). Additionally, the MPI defines surface fine sediment levels as PF when particles less than 6mm are less than 12%; FAR when these levels are 12-20%; and NF when these levels are greater than >20%. Therefore, sub-surface fines <0.85mm less than 12% and surface fines <6mm less 12% are the desired condition for fish habitat (USDA et al. 2004).

Fine sediment levels in the project area streams were assessed using 2010-11 pebble count data collected in the project area (USDA 2011b) using the Wolman Pebble Count method (Wolman 1954), which measures particle sizes less than 6mm. Twenty-three pebble counts were collected across the Buttermilk and Libby Creek drainages, focusing on the main fish streams. The sediment data is shown in the **Figure 18**.

Figure 18. Pebble count data in project area

Survey Location	Year	% fines <6mm	Sediment Rating
Buttermilk Creek Reach 1	2011	10	PF
East Fork Buttermilk Creek Reach 1	2011	8	PF
East Fork Buttermilk Creek Reach 2	2011	5	PF
West Fork Buttermilk Creek Reach 1	2011	1	PF
West Fork Buttermilk Creek Reach 2	2011	6	PF
West Fork Buttermilk Creek Reach 3	2011	11	PF
Libby Creek Reach 2	2010	19	FAR
Libby Creek Reach 3	2010	26	NF
Libby Creek Reach 4	2010	17	FAR
Libby Creek Main by HD 1	2010	14	FAR
Libby Creek Main by HD 2	2010	13	FAR
Libby Creek Main by HD 3	2010	16	FAR
Libby Creek Main by HD 4	2010	21	NF
North Fork Libby Reach 1	2010	14	FAR
South Fork Libby Reach 1	2010	23	NF

This data suggest the Buttermilk drainage is properly functioning for fine sediment levels. Riparian roads and hillslope failures from past logging activities contribute excess sediment to the stream system, but the data suggest sediment is not a problem in fish habitat. It is important to note that Buttermilk Creek, including the West Fork and East Fork Buttermilk Creek tributaries, has mostly steep gradient channels with high sediment transport capacity. Most fine sediment in the drainage is transported to the Twisp River, which is generally low in fine sediment levels (USDA 2011a; Lookout Mountain AMP Biological Assessment). Very little bank erosion exists in the fish bearing streams, further indicating the sediment regime is properly functioning.

Fine sediment levels are elevated within the Libby Creek drainage. Three out of the nine sites monitored had surface fines categorized as Not Functioning and the remaining six sites were Functioning At Risk. Fine sediment levels less than 1mm were below the Forest Plan standard. Bank stability in the main fish streams was greater than 95%, which is considered excellent. Some tributary streams are receiving bank damage from livestock, but it has been minor across the sub-watershed. The higher fine sediment levels is likely due to the high road density in several areas across the sub-watershed. Fine sediment within the Libby Creek drainage is Functioning At Risk and below desired levels for fish production.

Resource Indicator Summaries

The existing condition of resource indicators and measures at the sub-watershed scale are summarized in **Figure 19** below.

Figure 19. Water resource indicators for project area.

Resource Element	Measure	Existing Condition (Alternative 1) Buttermilk Cr	Existing Condition (Alternative 1) Libby Cr
Water quality	Road Density	1.3 mi/mi^2	2.1 mi/mi^2
	Road drainage network increase (artificial streams)	20%	40%
	Riparian road density	1.4 mi/mi^2	4.0 mi/mi^2
	Road-stream crossing density	0.5 crossings/mi	1.2 crossing/mi
	Ground cover (amount of bare soil)	Same as existing	Same as existing
Water quantity	Number of beaver habitat enhancement sites	0	0
Aquatic Habitat	Miles of stream channel restored with coarse woody debris	0	0

Resource Element	Measure	Existing Condition (Alternative 1) Buttermilk Cr	Existing Condition (Alternative 1) Libby Cr
	Number of Aquatic Organism Passage (AOP) pipes installed	0	0
	Increase in miles of stream accessible to fish	0	0

Resource Indicator: Road Density

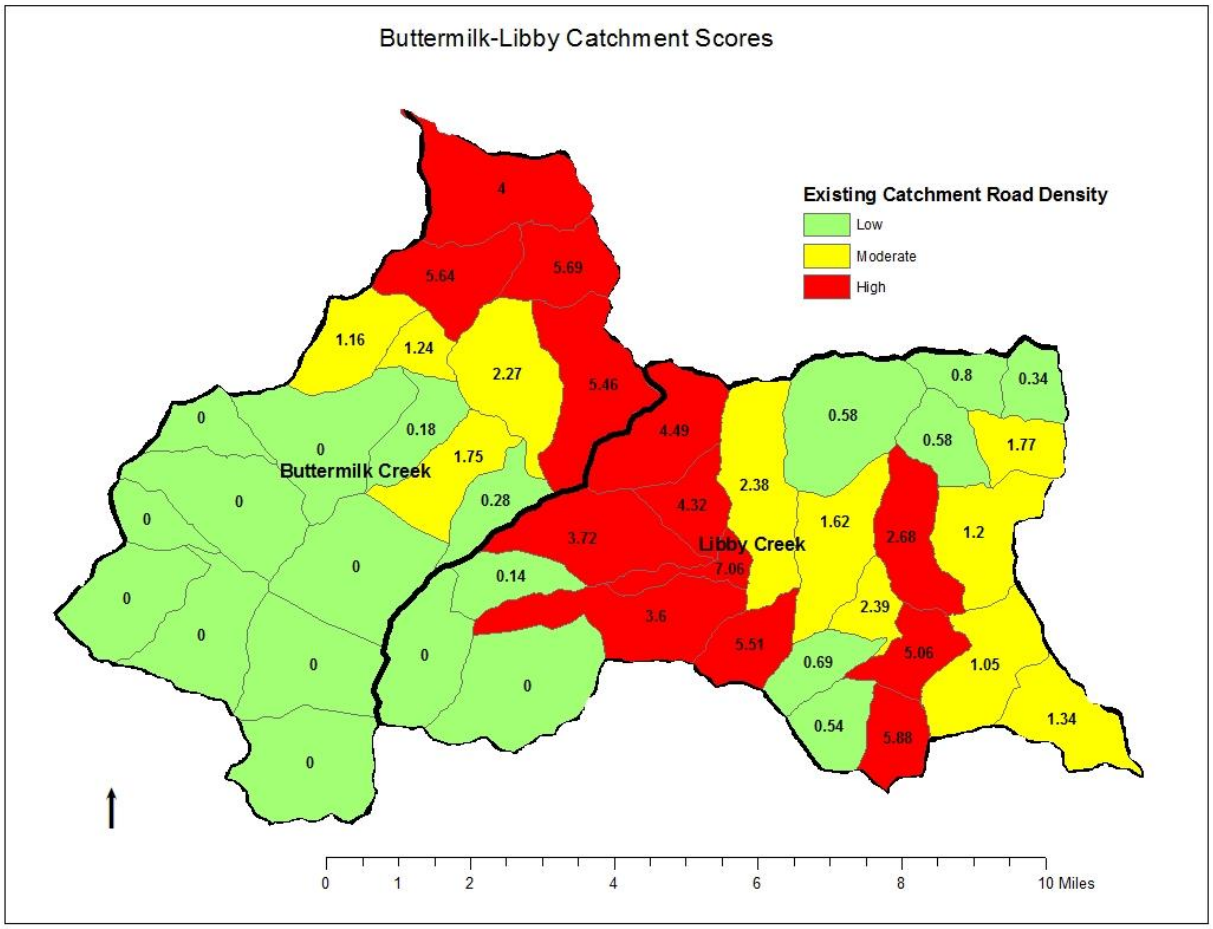
Road densities in the Buttermilk and Libby Creek drainages are generally lower than other many other areas across the Methow Valley Ranger District and are within the Functioning At Risk category, as shown in Figure 20.

Figure 20. Total road miles and road density at the sub-watershed scale.

Sub-watershed	Total road miles	Sub-watershed Acres	Sub-watershed Road Density
Buttermilk Creek	54.4	23500	1.3
Libby Creek	76.1	25500	2.1
Total	**130.5**		

At the more localized scale of direct road-stream interactions, the WWRP analysis calculated road densities at the catchment level (Figure 21), categorizing road density as high across 36% (13 total) and moderate across about 20% (11 total) of the catchments. Most catchments with low road density are in Wilderness. This indicates negative road-stream interactions are likely occurring in the lower and eastern portion of the Buttermilk Creek drainage and in the upper and middle portion of the Libby Creek drainage.

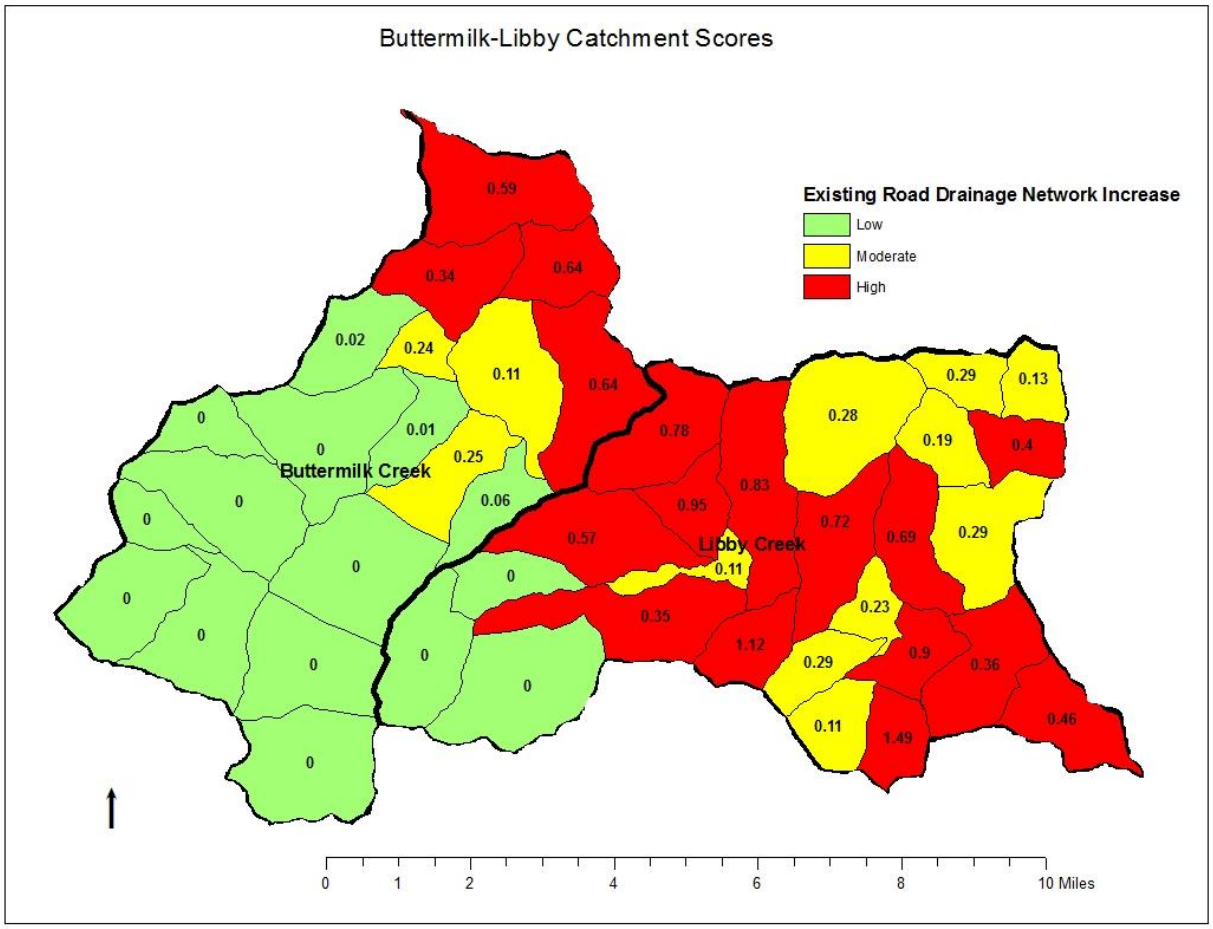
Figure 21. Road density by catchments.



Resource Indicator: Road Drainage Network

Increases in drainage network from the road system across the Buttermilk and Libby Creek sub-watersheds are shown in Figure 22. Over 40% of catchments are within the high category and over 20% are in the moderate category for this metric indicating that hydrologically connected roads are one of the primary drivers of impaired function in the Mission Project area. The lower third of the Buttermilk Creek drainage has a substantial increase in artificial streams as does most of the Libby Creek drainage.

Figure 22. Increase in drainage network from the road system by catchments.



Resource Indicator: Riparian Road Density

Figure 23 shows the current riparian road density levels and rating by catchment across the project area. Fifty percent of the catchments are rated high and 13% are rated moderate for riparian road density, indicating where riparian roads are abundant with greater potential for negative road-stream interactions. This indicator can be misleading because it overestimates negative road-stream interactions. For example, the red catchment in top center of Libby Creek has a riparian road density of 2.6, but is less of a concern because the total road density is low at 0.6 mi/mi^2. The catchment road density and riparian road density were averaged to identify where general road density is high within RRs, showing where the greatest potential for negative road-stream interactions exists (shown in Figure 24).

Figure 23. Existing riparian road density by catchments.

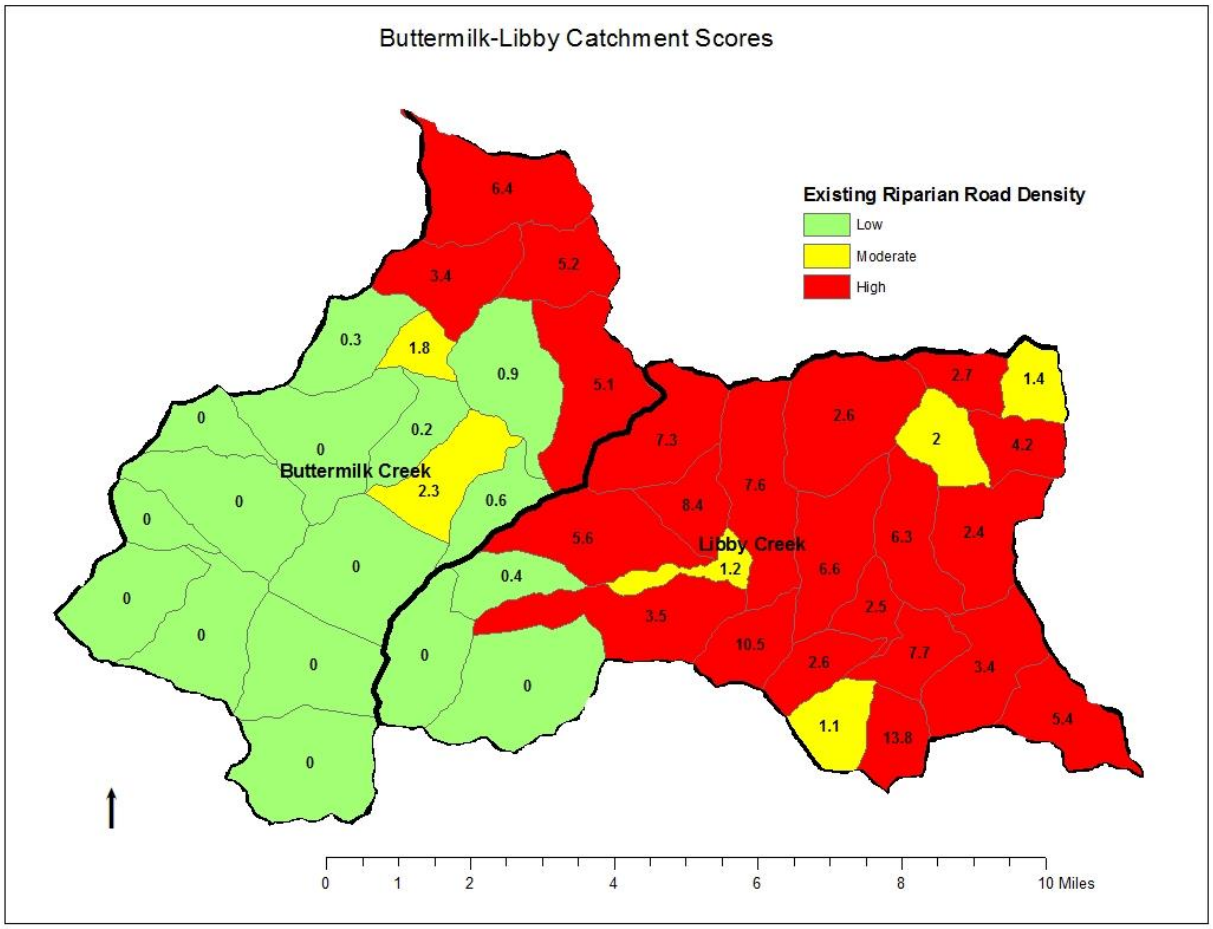
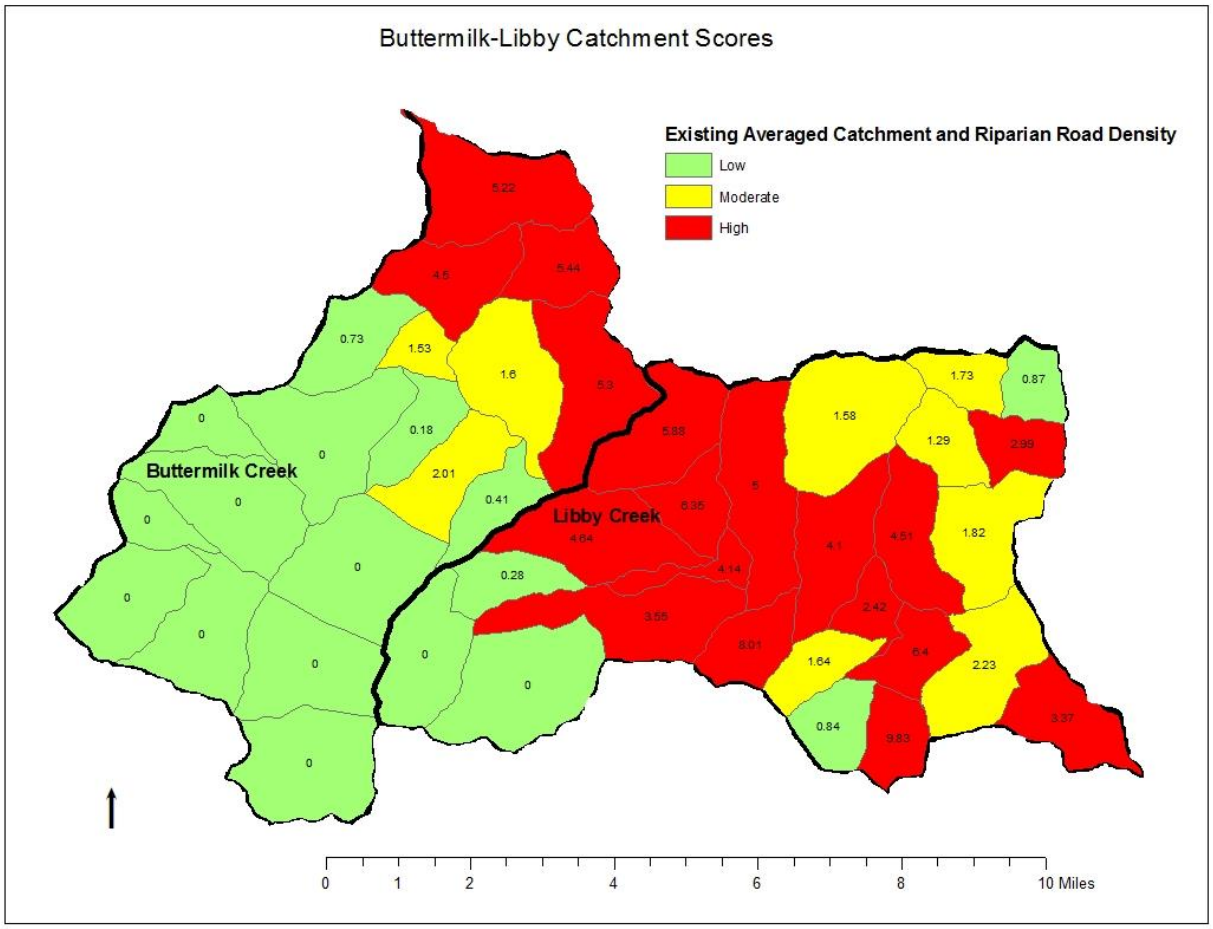


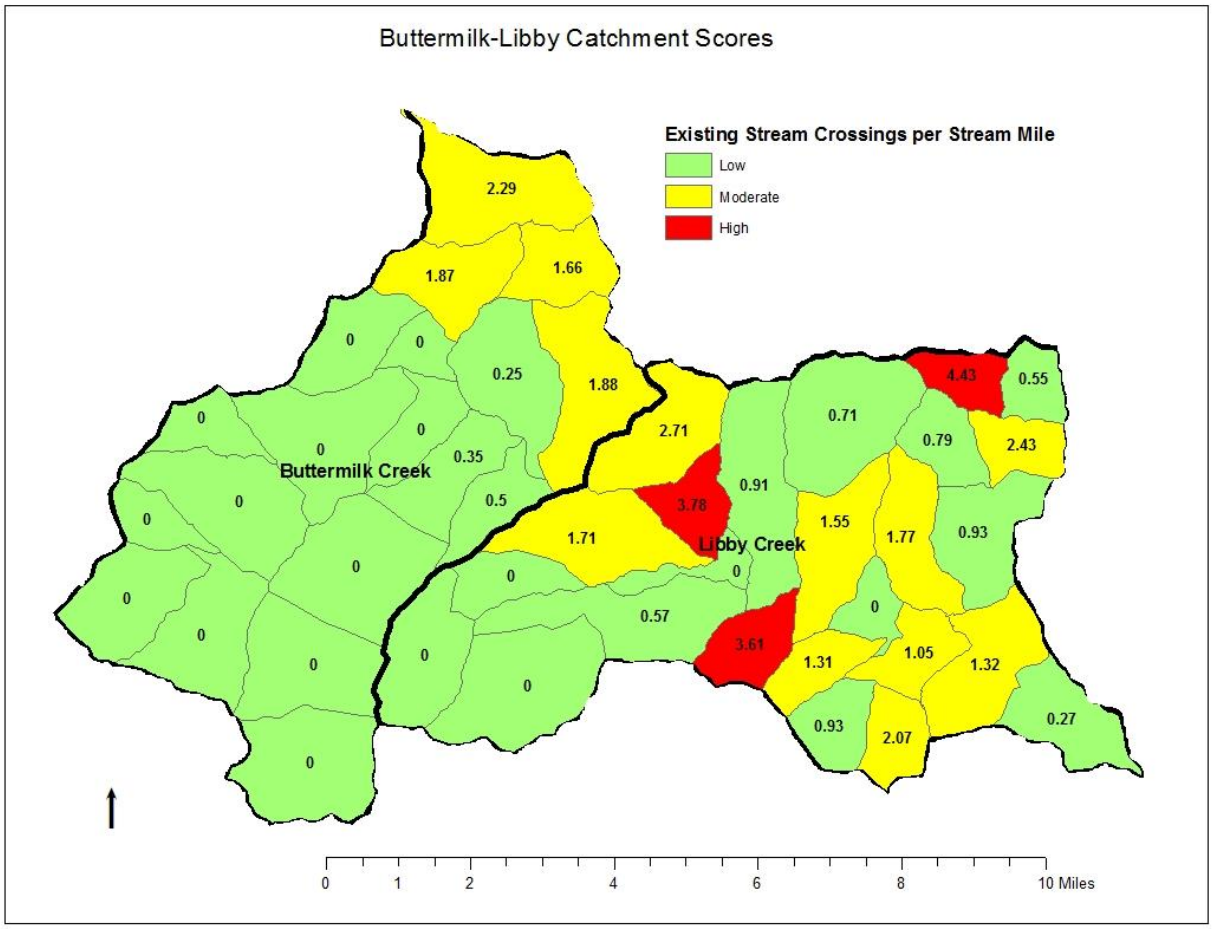
Figure 24. Existing averaged catchment and riparian road density by catchments.



Resource Indicator: Stream Crossings per Mile

The number of stream crossings per mile of stream within the project area are shown in Figure 25. Many catchments are rated low for this indicator because they lie within Wilderness in the sub-watersheds. Many catchments are “functioning at risk” for this metric. The northeastern red catchment in Libby Creek is inaccurately shown as “high” because field review found only one stream in the catchment with no road crossings; this catchment should be disregarded. There are an estimated 109 stream crossings in the project area; 47 crossings are open to vehicle traffic and have approaches greater than 3% slope, which increases the risk vehicle traffic delivering sediment into streams.

Figure 25. Existing number of stream crossings per mile of stream by catchments*



**Red catchment in the northeastern area of Libby Creek (labeled "4.43") should be disregarded as a GIS error.*

Resource Indicator: Ground Cover

Observed levels of ground cover within the RRs are currently effective at trapping and filtering sediment. Areas of trailing, compaction, and bare soil are present where livestock have access to streams. Cover consisted primarily of grass, forb vegetation, shrubs, and needle cast/litter. The majority of bare soil within the project area is related to road surface area; historical harvest prescribed fire, and cattle grazing also created areas if bare soil. The current amount of bare ground is regarded as the baseline for comparison to Alternatives 2 and 3.

Resource Indicator: Beaver Habitat

Past hunting and trapping substantially reduced beaver populations in the project area. The number of beavers in the project area is unknown, but substantially below historic levels and below what is desired. Without adequate beaver populations to maintain historical habitats, conifer encroachment has helped reduce suitable areas for colonization. The ongoing WADFW

beaver reintroduction project has limited options for releasing beaver in the project area, where successful recolonization would improve riparian habitat and water storage capacity.

Resource Indicator: Stream Channel Complexity
The amount of large wood in stream channels ranges from 44.6 to 221.2 pieces per mile at 6 inches diameter and greater. Large log pieces greater than 12" in diameter and over 35 feet in length totaled from 0.7 to 9.7 pieces per mile. The main stem Buttermilk Creek, West Fork Buttermilk Creek, Black Pine Creek, Libby Creek, and North Fork Libby Creek have reaches with coarse wood levels below desired levels, resulting in limited channel complexity that creates desired aquatic habitat.

Resource Indicator: Fish Distribution
Fish inventory surveys identified current fish distribution in the project area and culvert inventories identified barriers to fish passage on fish-bearing streams and fishless streams that have suitable habitat conditions. Eight barrier culverts exist in the project area that are blocking or partially blocking fish passage to about 5.6 miles of potential fish habitat. Within drainages, migrations are important for juvenile and adult fish to find refugia from warmer temperatures and predators, find feeding areas and to have reproductive success. These barriers disrupt habitat connectivity that helps increase resilience to natural disturbances that will be increasingly important with anticipated changes in climate.

3.3.4 Environmental Consequences

3.3.4.1 Considered, but not Analyzed in Detail

The following indicators or identified issues were considered, but were dropped from further analysis as listed in the rationale in Figure 26.

Figure 26. Water Resources Considered but Not Analyzed in Detail

Resource/Identified Issue	Rationale for Dismissing from Further Analysis
Chemical contaminants	Use of equipment or fueling of equipment in proximity to stream can add toxins to waterways. This indicator is mitigated to negligible levels due to implementation of design criteria that keep chemical contaminants outside areas where they could be delivered to streams in measurable volumes or contained by Best Management Practices (BMPs).
Floodplain Habitat	There is little floodplain in the project area due the higher gradient channels. Stream channels are mostly Rosgen (1994) type A channels with a few type B reaches. These channel types typically have little or no floodplain. This project would not change watershed conditions that would alter the small amount of floodplain in the project area. Therefore, this resource indicator does not apply to this project.

Resource/Identified Issue	Rationale for Dismissing from Further Analysis
Water Quantity (Peak flow)	This project will not impact water yield in any measurable way from vegetation cover removal. Research from 95 watershed experiments conducted in the United States forests show that on average, annual runoff increased only ~0.1 inches for each 1% of watershed area harvested (Stednick 2006). This issue will not be carried forward since there are no clear cut harvest areas proposed and regeneration harvests (selective seed tree) proposed are equivalent to ~1% of the watershed in this project. Project Design Criteria require that no more than 20% of any watershed area be treated annually (Stednick 2010), Beche et al. 2005). Riparian Harvest, beaver introduction and increases in drainage network from roads will be discussed as it pertains to water yield.
Water Quality (temperature)	This project will not have a measurable effect upon temperature at the reach or HUC scale. Direct solar radiation is the largest driver for temperature alteration and the removal of a few overstory trees along fish streams will not decrease shading or increase temperature. Thinning treatments would stay outside of the inner buffers of RRs and retain adequate vegetation to provide shade. Prescribed fire treatments in RRs would be designed to retain adequate vegetation to avoid impacting shade.
Livestock Grazing	See Figure 5 in Chapter 1.
Private Irrigation Withdrawals	This is discussed as it pertains to cumulative effects and existing condition. Water rights are a legal issue outside of the scope of this project, which will not change any existing rights or withdrawals.

3.3.4.2 Alternative 1 – No Action

3.3.4.2.1 Effects

Resource Indicator: Road Density

Under this alternative, no changes to project area roads would occur, resulting in ongoing adverse, long-term, and moderate effects to water resources. Current road densities would continue to function at risk, and moderate to high road densities would remain unchanged, causing continuing adverse hydrologic and ecological effects as discussed previously. Roads in unstable condition would continue to deteriorate and sediment delivery will continue to occur. There would be no improvement in the condition of roads except as occurs through increasingly limited regular road maintenance that is constrained by decreases in funding.

Resource Indicator: Road Drainage Network Increase

Roads would continue to artificially increase the drainage network at the same level. The catchments with high and moderate drainage network increases would continue to move water out the system at an increased rate, with some increase in the magnitude and frequency of peak flows. Libby Creek has more catchments rated as high or moderate, suggesting substantial hydrologic connectivity between the roads and the stream network; therefore taking no action would likely cause adverse, long-term, moderate effects to water resources and departure from historical conditions would continue. Peak flows would increase compared to historic conditions, which can have negative consequences to spawning and redd incubation from sediment transport.

Resource Indicator: Riparian Road Density
This alternative would not improve water quality indicators by reducing high fine sediment levels from road impacts. Where riparian road densities are high, degraded stream conditions would remain. Low riparian road density in the Buttermilk sub-watershed would result in continued adverse, long-term, and minor effects to water quality. With higher levels of riparian road density, the Libby sub-watershed would continue to experience high road-stream interactions that would create ongoing elevated stream sediment levels in Libby Creek, causing adverse, long-term, moderate effects to spawning habitat and keep it in an “at risk” state.

Resource Indicator: Stream crossings per mile
The current number of stream crossing across the project area would remain. Catchments in lower Buttermilk and across Libby would have moderate to high density of stream crossings that would continue to be sources of chronic sediment delivery, and would likely cause adverse, long-term, and moderate effects to water resources. Fine sediment levels in Libby Creek would remain elevated, reducing habitat quality for ESA-listed fish and limiting fish production.

Resource Indicator: Ground Cover
Ground cover within the RRs and upper watersheds would remain at existing levels, effectively trapping and filtering sediment under existing conditions where vegetation and topography exclude livestock. Taking no action would have beneficial, long-term, negligible effects to riparian cover and water resources.

Resource Indicator: Beaver Habitat
The lack of enhancements that create suitable beaver habitat would have adverse, longer-term, minor effects on the potential for beaver reintroduction. Wetlands associated with beavers would not be created to form natural water storage features that would supplement summer and fall base flows, which would continue to diminish due to irrigation and domestic water withdrawals in Buttermilk and Libby Creek. At-risk aquatic species in the project area would continue to have reduced habitat, lower quality refugia from warm water and predators, and more competition for space during summer and fall months.

Resource Indicator: Stream Channel Complexity
Important spawning and rearing reaches in the project area would remain below desired conditions because, while natural wood accumulation would occur in stream channels, limited amounts of large wood would be available to contribute complexity to instream fish habitat, resulting in adverse, long-term, minor effects to this indicator. Instream wood levels in certain reaches that are well below desired wood loading for complex, high quality fish habitat would likely remain unchanged over the long term because the underlying processes that lead to natural wood recruitment (e.g. growth of large trees and more natural wood recruitment rates) take many decades or centuries (Shull and Butler 2014). Survival and population abundance for at-risk ESA species would continue to be limited in the Buttermilk Creek and Libby Creek drainages.

Resource Indicator: Fish Distribution
About six miles of suitable fish habitat would remain fragmented with partial or no access, leading to adverse, long-term, moderate effects on fish populations due to the lack of habitat

connectivity and the vulnerability of isolated populations to natural disturbances, especially those anticipated with warmer, drier climates. Preventing full habitat access to suitable habitat would limit localized fish production and hinder recovery efforts for at-risk fish species.

3.3.4.2.3 Summary of Alternative 1 (No Action)

Alternative 1 would have no direct impacts to water quality, fish habitat, and individual fish species. However, the existing road network would continue to contribute excessive fine sediment levels that would maintain high fine sediment levels in Libby Creek. Fish habitat complexity would continue to improve naturally, but at a pace that would likely take decades to create suitable habitat conditions. Low base flows would continue to be a limiting factor that reduces fish production. Fish barriers would remain, preventing full habitat access and maximum fish production. In the long term, taking no action would maintain current at-risk hydrologic processes and aquatic habitat conditions that would impede recovery of ESA-listed fish species.

3.3.4.3 Alternative 2 and 3 – Proposed Action Effects Common to Both Action Alternatives or to Alternative 2 Only

3.3.4.3.1 Effects

Alternatives 2 and 3 have the same proposed actions except that Alternative 3 increases the amount of road decommissioning, creates hardened fords, and applies additional rock armoring at stream crossings beyond the six identified in Alternative 2. This alternative does not entail replacing the bridge across West Fork Buttermilk Creek. For this section, the effects common to both action alternative or to Alternative 2 only will be analyzed. Ladder fuel reduction (LFR) and prescribed burning are treatments proposed to make stands in riparian areas more resilient to the impacts of uncharacteristic wildfire. The effects of these treatments will be discussed in detail within the fire/fuels section in this document.

Figure 27: Water Resource Indicators and Measures for Alternatives 2 and 3

Resource Element	Indicator	Measure	Alternatives 2 and 3
Water Quality (Sediment)	Road density	Number of Catchment Rankings Lowered*	**5** (3 High to Moderate, 2 Moderate to Low)
	Road drainage network increase		**5** (2 High to Moderate, 3 Moderate to Low)
	Riparian road density		**8** (4 High to Moderate, 4 Moderate to Low)*
	Road-stream crossing density		**6** (1 High to Low, 1 High to Moderate, 4 Moderate to Low)
	Groundcover	Acres of bare soil	+105 acres
Water Quantity (base flow)	Beaver habitat	Number of beaver habitat enhancement sites	6 sites

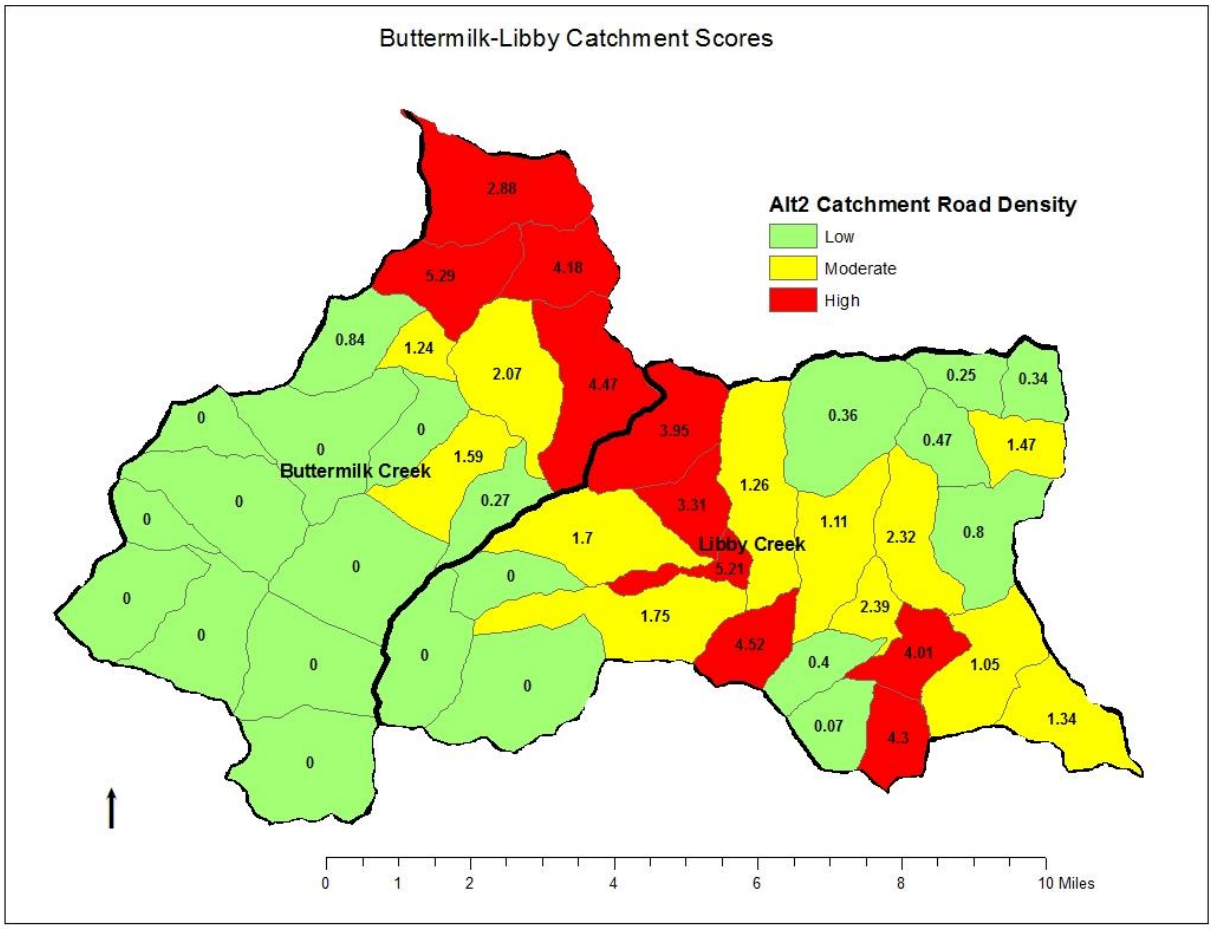
Resource Element	Indicator	Measure	Alternatives 2 and 3
Aquatic Habitat	Stream channel complexity	Miles of stream restored with course woody debris	8.3 miles
	Fish distribution	Increase in miles of accessible fish stream habitat	5.6 miles
		Number of aquatic organism passage (AOP) pipes installed	8 AOPs

* Changes in catchment rankings listed are for the averaged catchment road density and riparian road density, showing where riparian road density coordinated with catchment density, which is a more meaningful metric.

Resource Indicator: Road Density

About 35 miles of roads would be decommissioned, prioritizing riparian roads. At the sub-watershed scale, road density would decrease 18 % (from 1.3 mi/mi^2 to 1.1 mi/mi$^{2)}$ in Buttermilk Creek and by 28% (2.1 mi/mi^2 to 1.5 mi/mi^2) in Libby Creek. About 35 miles of roads would be hydrologically closed across the project area by removing stream crossings, constructing water bars, and/or surface scarification. Road density would decrease at the sub-watershed scale and within some key areas in Libby Creek, as displayed in Figure 28. Chronic sediment delivery would decrease across the project area with the greatest reduction in Libby Creek. The amount of riparian roads removed would create a long-term, negligible, beneficial effect in Buttermilk Creek and a long-term, minor, beneficial effect in Libby Creek.

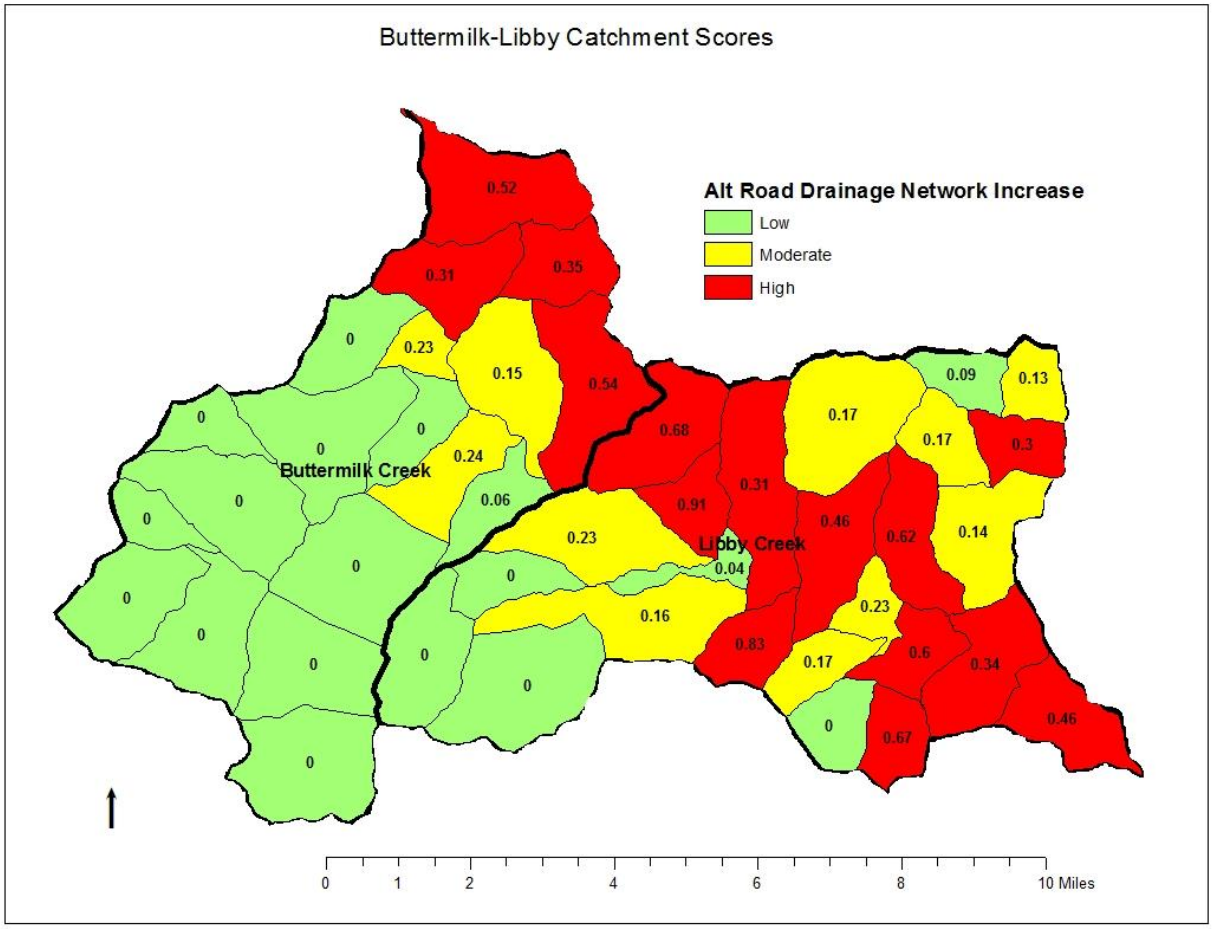
Figure 28. Alternative 2 road density by catchments.



Resource Indicator: Increase in road drainage network

The road drainage network would decrease by about 30% across the project area. At the sub-watershed scale, Buttermilk would decrease by 15% and Libby by 35%. A reduction in the road drainage network would improve watershed condition and move the system towards a more natural flow regime. Figure 29 displays catchment road drainage network under Alternative 2. No catchment rankings would change in the Buttermilk sub-watershed. The small improvement in Buttermilk is not expected to result in a measurable change in stream flow. In Libby, five catchments would be improved, causing a slight improvement to peak flow frequency and magnitude and a small improvement to base flow. Proposed actions would have long-term, negligible, beneficial effects on peak and base flows.

Figure 29. Increase in drainage network from the road system by catchments



Resource Indicator: Riparian Road Density

Riparian road density would decrease by about 35% in the Libby sub-watershed and 17% in Buttermilk sub-watershed. At the catchment scale, riparian road density rankings in Buttermilk would not change while nine catchments in Libby would drop in density rankings, indicating an improvement for reducing road-stream interactions (Figure 30).

In the averaged catchment/riparian road density rankings, moderate to high riparian road density would decrease in key areas around North Fork and South Fork Libby, Ben Canyon, and Hornet Draw Creeks (Figure 31), resulting in fewer road-stream interactions. A reduction in riparian roads to lead to improved watershed condition because, as roads are rehabilitated, vegetation would re-establish and would prevent surface erosion. Since the current road mileage in Buttermilk sub-watershed is already low, the small reduction in roads proposed by

this alternative would have a long-term, negligible, beneficial effect. The Libby sub-watershed has more proposed road decommissioning, which would result in a long-term, minor, beneficial effect over existing road conditions because sediment from several remaining riparian roads would continue to contribute to altered hydrologic function.

Figure 30. Alternative 2 riparian road density by catchment

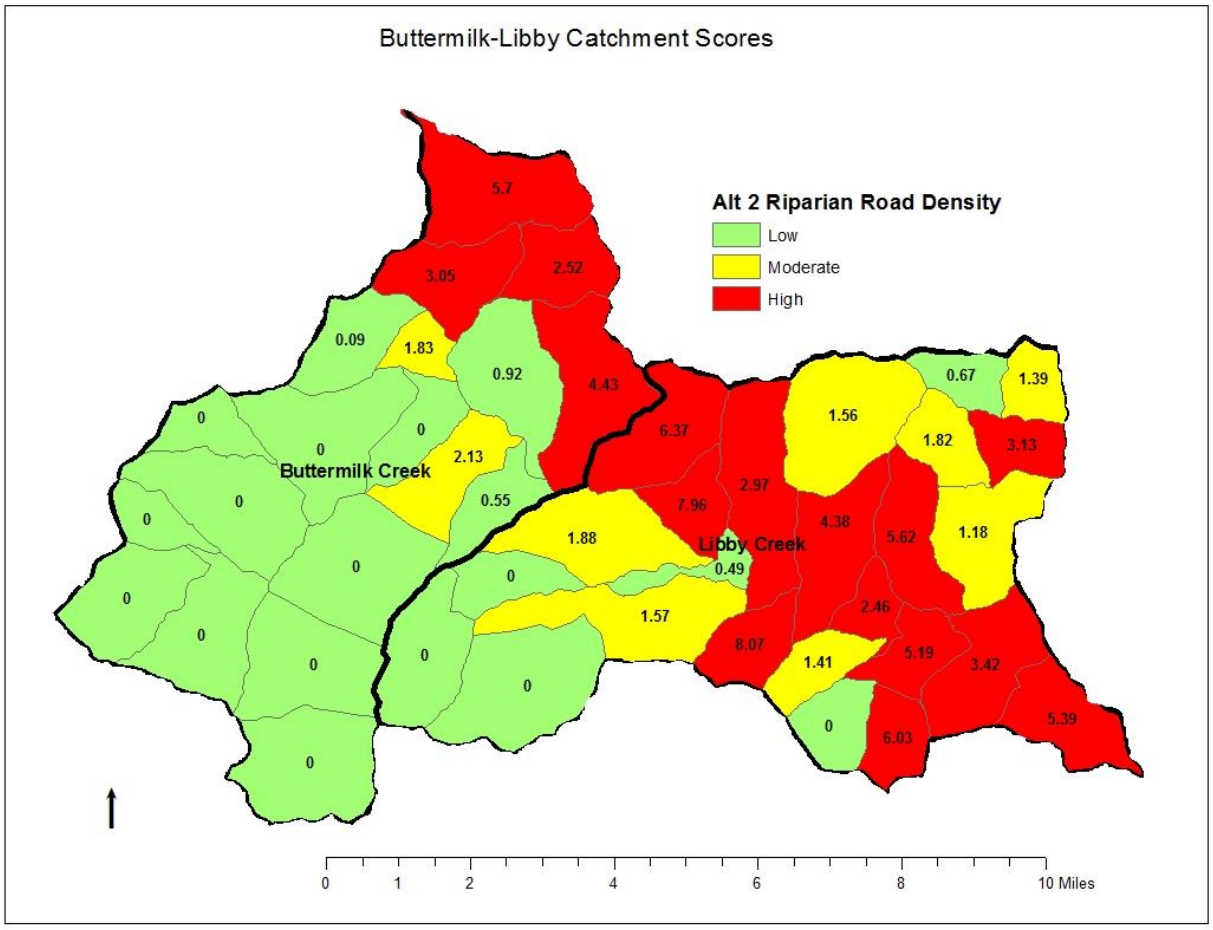
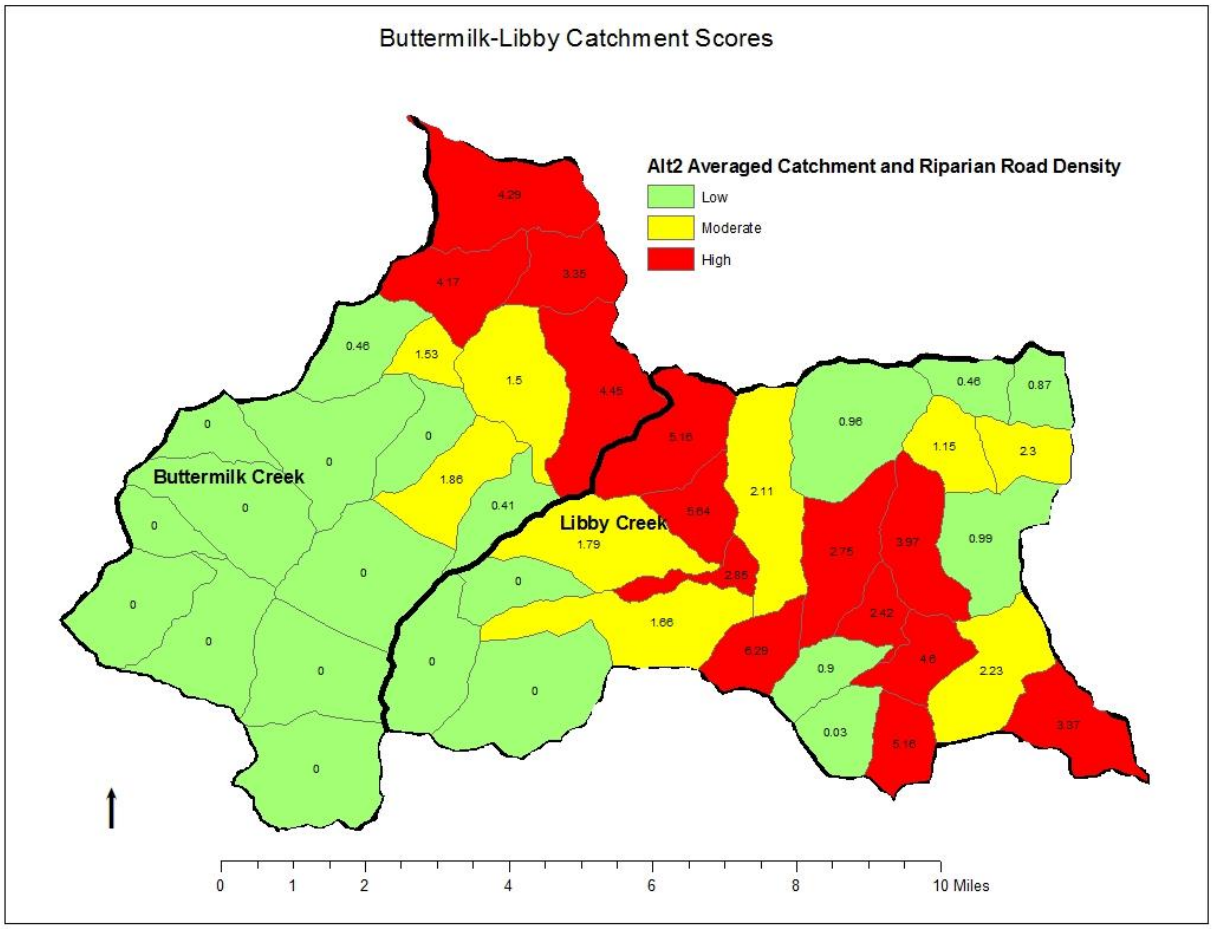


Figure 31. Alternative 2 averaged catchment and riparian road density by catchments

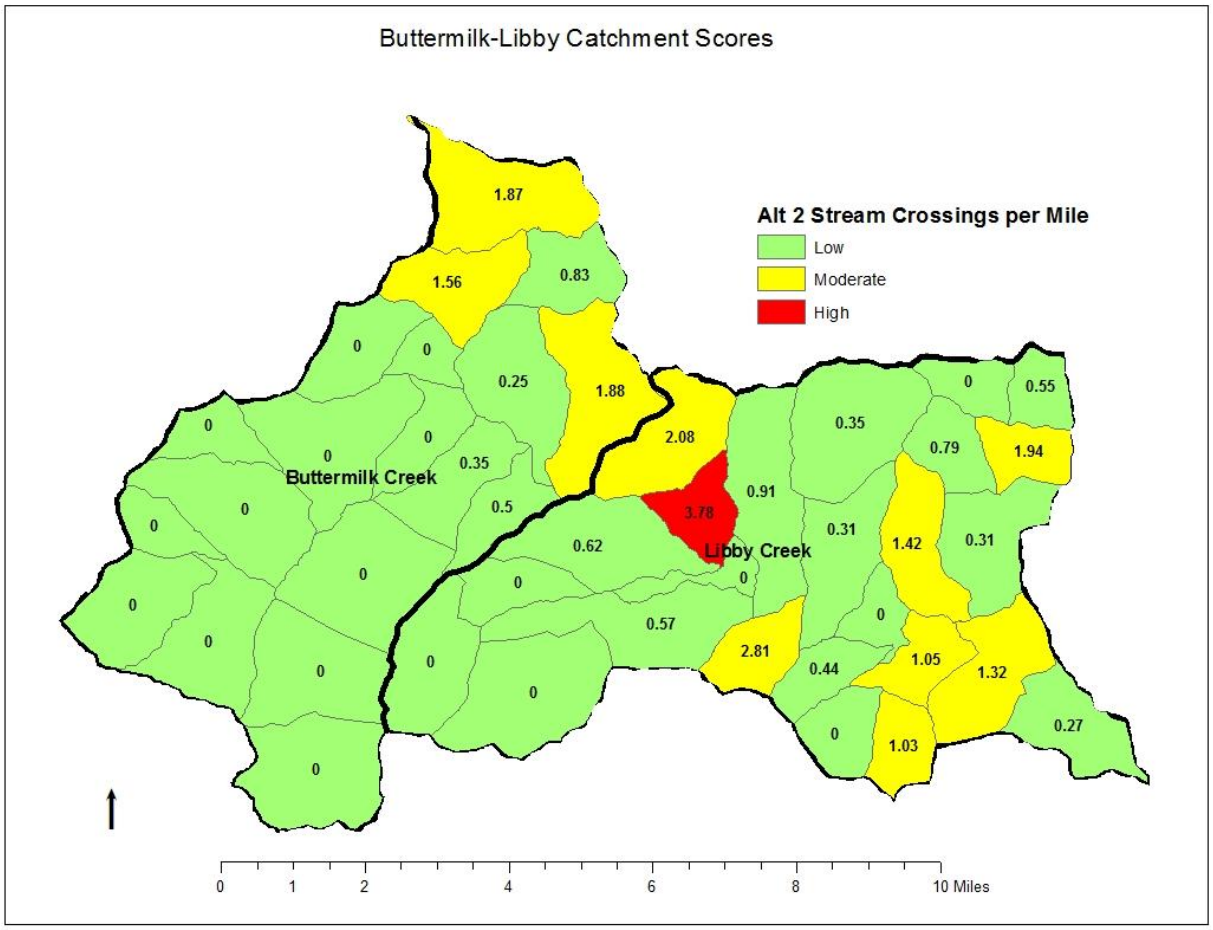


Resource Indicator: Stream Crossings per Mile

Alternative 2 would remove up to 40 stream/draw crossings across the project area that includes 6 perennial streams, 23 intermittent streams, and 11 ephemeral draws. Stream crossings per mile density would decrease by about 32% across the project area (about 13% in Buttermilk Creek and 38% in Libby Creek). Reductions in catchment ratings would occur in both sub-watersheds (Figure 32). Changes in the Buttermilk sub-watershed would be minor, affecting one catchment that would improve from moderate to low ranking. For Alternative 2 only, the bridge over West Fork Buttermilk Creek, on road 4300550, would be replaced with a similar open-bottom structure, allowing for fish passage. Construction actions would follow all applicable BMPs in order to reduce effects from sediment. The Libby sub-watershed would have improvements in five catchments, two moving from high to moderate ranking and three moving from moderate to low ranking. By eliminating sediment delivery sources at road crossings, Buttermilk would see a slight reduction in sediment sources while Libby would see a greater reduction in sediment sources. The change in stream crossing density would result in a

negligible, beneficial, long-term effect in the Buttermilk sub-watershed and a minor to moderate, beneficial, long-term effect in the Libby sub-watershed.

Figure 32. Alternative 2 number of stream crossings per mile of stream by catchment



Resource Indicator: Ground Cover

Proposed activities would cause a temporary increase in approximately 102 acres of bare soil over the life of this project. Not all of these bare acres would be created at the same time because treatments would be implemented at different timeframes (i.e. prescribed burning would occur approximately one to three years after thinning, and thinning would be spread over approximately 10-12 years as dictated by funding, unit layout, contractor availability and other factors). Temporary roads created to facilitate commercial thinning activities would create an additional ~3 acres of bare soil, with limited impacts to aquatic habitat due to Best Management Practices (BMPs) and temporary road locations that would minimize the delivery of sediment to any stream channels (including no new stream crossings and avoidance of RRs). Temporary roads would be decommissioned after treatments.

Proposed reductions in effective ground cover in RRs would be avoided, minimized, and mitigated by project design criterion to limit bare soil creation near surface water areas. Thinning and prescribed fire activities would be designed to maintain effective groundcover and utilize existing roads, skid trails, and landings to minimize the creation of more disturbed soil. About 272 acres (8 acres bare soil) of underburning would occur in RRs. Design criteria and objectives would provide for low to moderate fire behavior, resulting in low potential to generate short-term fine sediment that would not likely substantially impact riparian buffer efficacy. Sediment delivery to streams would likely be minimal from treatment units, with no likely measurable increase in fine sediment from the proposed treatments. Thinning and prescribed fire treatments would not likely generate measurable increases in sediment yield due to buffers and other design criterion that provide for retention of ground cover and vegetation in RRs during treatments (Appendix D). Prescribed fire treatments would occur over approximately 15 years because of limitations in funding, staffing, burn prescription windows, and smoke approval, which would result in spreading the minimal impacts described above over lengthy periods and allowing for recovery. Measures listed in Appendix D would provide for ongoing evaluation of effects of treatments on aquatic/hydrologic resources in RRs and provide for rapid changes and/or cessation of activities if undesirable effects.

The increase in bare soil would be temporary, taking approximately one to three years before vegetation re-established enough to effectively cover exposed soil and prevent surface erosion, but the duration would be long-term as defined. Areas with created bare soil would be dispersed across the project area and only a small proportion would occur within RRs (< 0.3%). The increase in bare soil would result in negligible, adverse, long-term impact to the indicator and stream sediment levels.

Resource Indicator: Beaver Habitat

Proposed beaver habitat enhancement treatments would occur at suitable sites (2 locations in the Buttermilk sub-watershed and 4 locations in the Libby sub-watershed) selected with input from WA DFW staff successfully working on beaver reintroduction in the local area. Treatments would be designed to encourage beaver use and improve successful colonization rates, and would include:

- Construction of six beaver dam analogs (BDAs) by installing natural wood posts and brush to encourage establishment of colonies;
- Tree girdling and commercial harvest of conifers to promote hardwood vegetation and beaver forage production (~68 acres);
- Falling trees into the channel to create additional complexity and pool formation in habitat enhancement areas as needed;
- Riparian fencing to keep cattle out of wet meadows while beavers establish themselves.

Soil restoration treatments proposed in this project would entail sub-soiling compacted areas near beaver habitat enhancement areas and elsewhere; this treatment would increase the soil water holding capacity and infiltration rate in riparian areas and help increase water yield (See Soils, Section 3.4).

These enhancements would case short-term increases in turbidity where posts are installed. If colonies are successfully established, in the long-term beavers could increase natural water storage that would increase base flows during the summer and fall months, improving rearing habitat for juveniles and holding habitat for adult fish, potentially persisting for years (Pollock et al. 2003). At the site scale, the improvement in low flows below the release sites would be moderate while at the sub-watershed scale, benefits would be small with a minor magnitude effect over the long-term.

Resource Indicator: Stream Channel Complexity
In this alternative, small to large diameter trees would be hand felled on eight miles of fish streams the project area and left onsite, rapidly increasing coarse woody debris levels and thereby improving conditions in important spawning and rearing streams. Once historical levels of stream channel complexity were reached, natural recruitment rates would maintain the amount of coarse woody materials at appropriate levels. The increase in stream complexity would improve a substantial portion of spawning and rearing habitat in the project area and would lead to beneficial, long-term, moderate effects to habitat quality.

Resource Indicator: Fish Distribution
Restoring habitat connectivity by removing barriers to fish passage at eight sites would allow fish access to about six miles of quality spawning and rearing habitat while causing minor, adverse, short-term sediment impacts minimized by use of BMPs. The increase in fish access would have a moderate, beneficial, long-term effect on local fish distribution and fish production because more fish habitat would be available for spawning and rearing, resulting in an increase of fish production in these areas at the sub-watershed scale and directly contributing to the recovery of at-risk ESA-listed fish species.

3.3.4.3.2 Cumulative Effects
Spatial and Temporal Context for Effects Analysis: The spatial boundary for analyzing the cumulative effects to hydrologic and aquatic resources is the Buttermilk and Libby Creek sub-watershed boundaries (HUC12). Project effects are not expected to extend outside of these sub-watersheds. The temporal scale for cumulative effects on stream channel function is 30 years. The temporal scale for cumulative effects on water quality, riparian function, and watershed condition is 10 years. These time scales reflect the amount of time needed for watershed projects to improve stream channel function.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis: Analysis of watershed history is essential to help predict effects of future management activities on water quality and watershed condition. Ongoing reasonably foreseeable actions in the project area sub-watersheds include livestock grazing, road maintenance, snowmobile trail grooming, recreation, and invasive weed treatments. Additional projects and conditions that contribute to potential cumulative effects are outlined in the “Cumulative Effects Considerations” document in the project file.

The project is not expected to create negative cumulative effects on water quality, riparian function, channel morphology, and watershed conditions because treatments in Alternative 2

would create improved overall conditions across the watershed (**Figure 27**). Localized increases of erosion and sedimentation would occur from the instream work and some riparian treatments, however this increase would be short in duration and is not expected to have a cumulative effect at the watershed scale.

The following resource indicator has potential cumulative effects:

Resource Indicator: Ground Cover
Proposed treatments would overlap with impacts from grazing, the road network, and recreation, creating a slight cumulative impact upon sediment with unmeasurable effects.

3.3.4.3.3 Summary of Cumulative Effects
Alternative 2 may affect, and would likely adversely affect, steelhead and bull trout species and their critical habitat. Adverse impacts would be temporary and negligible to minor in consequence. Habitat conditions for ESA-listed species would move towards desired habitat conditions. This project would contribute towards the recovery of these species across the Upper Columbia Basin.

3.3.4.4 Alternative 3 – Effects Unique to Alternative 3

This section analyzes effects of proposed treatments unique to Alternative 3, including additional road decommissioning and road closures, rock armoring, and conversion of some small stream crossings to hardened fords.

3.3.4.4.1 Effects
Figure 33 displays the changes to hydrologic and aquatic resource indicators in Alternative 3.

Figure 33: Water Resource Indicators and Measures for Alternative 3

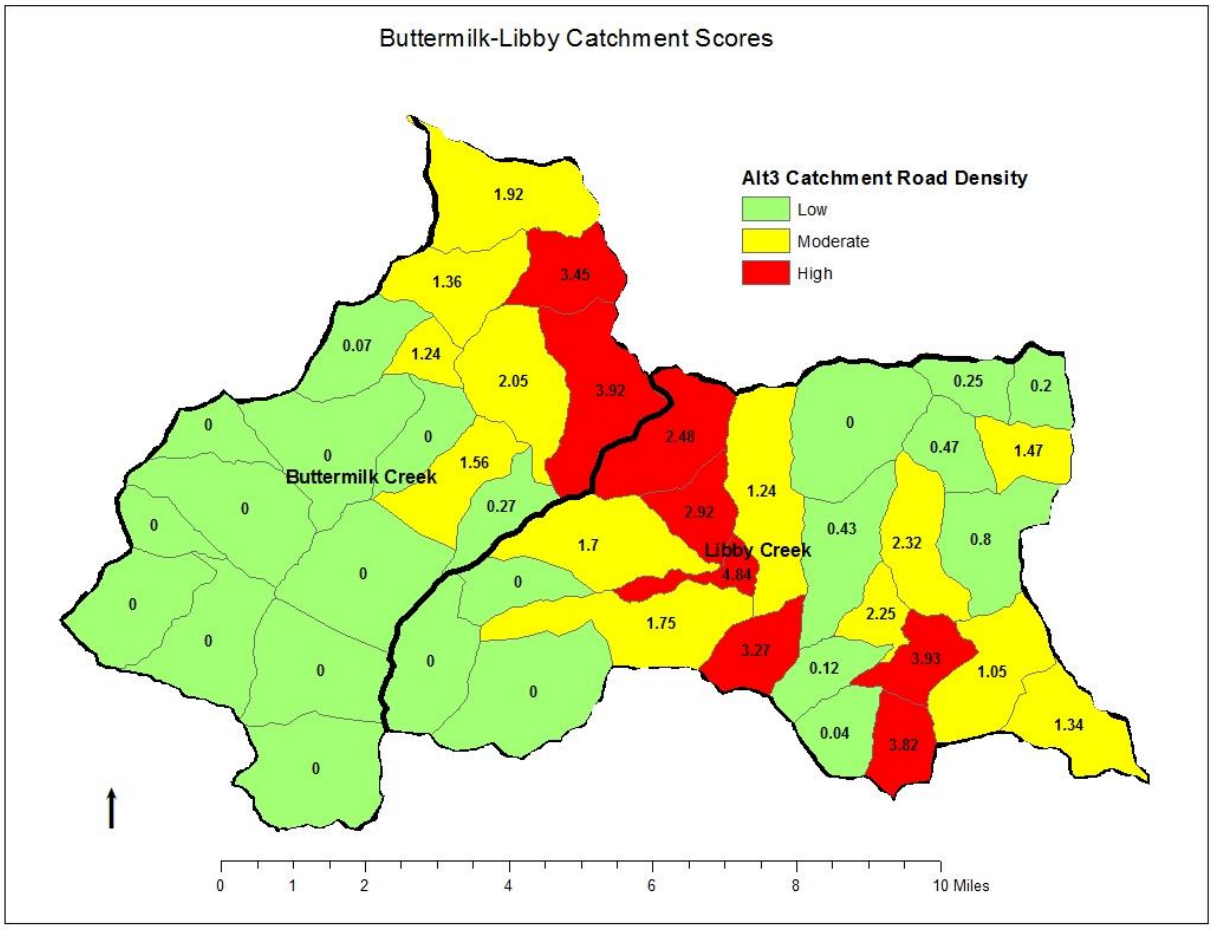
Resource Element	Resource Indicator	Measure	Alt 3 (% Change)
Water Quality (Sediment)	Catchment Road Density	Number of Catchment Rankings Lowered *	**8** (5 High to Moderate, 3 Moderate to Low)
	Road Drainage Network Increase		**10** (2 High to Low, 2 High to Moderate, 6 Moderate to Low)
	Riparian Road Density		**11** (2 High to Low, 5 High to Moderate, 4 Moderate to Low)
	Road-stream Crossing Density		**9** (1 High to Low, 7 High to Moderate, 1 Moderate to Low)

* Changes in catchment rankings listed are for the averaged catchment road density and riparian road density, showing where riparian road density coordinated with catchment density, which is a more meaningful metric.

Resource Indicator: Road Density
Approximately 57 miles of road decommissioning would occur in this alternative, prioritizing the removal of riparian roads. At the sub-watershed scale, road density would decrease about 37% (from 1.3 mi/mi^2 to 0.82 mi/mi^2) in Buttermilk and about 50% (from 2.1 mi/mi^2 to 1.05 mi/mi^2) in Libby. Approximately 29 miles of roads would be hydrologically closed across the project area as described under Alternative 2. Road density would decrease in most catchments that currently have roads. Five catchments with high road density would drop to moderate, making a

substantial reduction in road density in high concentration areas. Three moderate catchments would drop to a low ranking. Figure 34 displays road density by catchments under Alternative 3. Removing riparian roads at this level would result in moderate, long-term, beneficial effect to road density by reducing chronic sediment delivery sources across the project area.

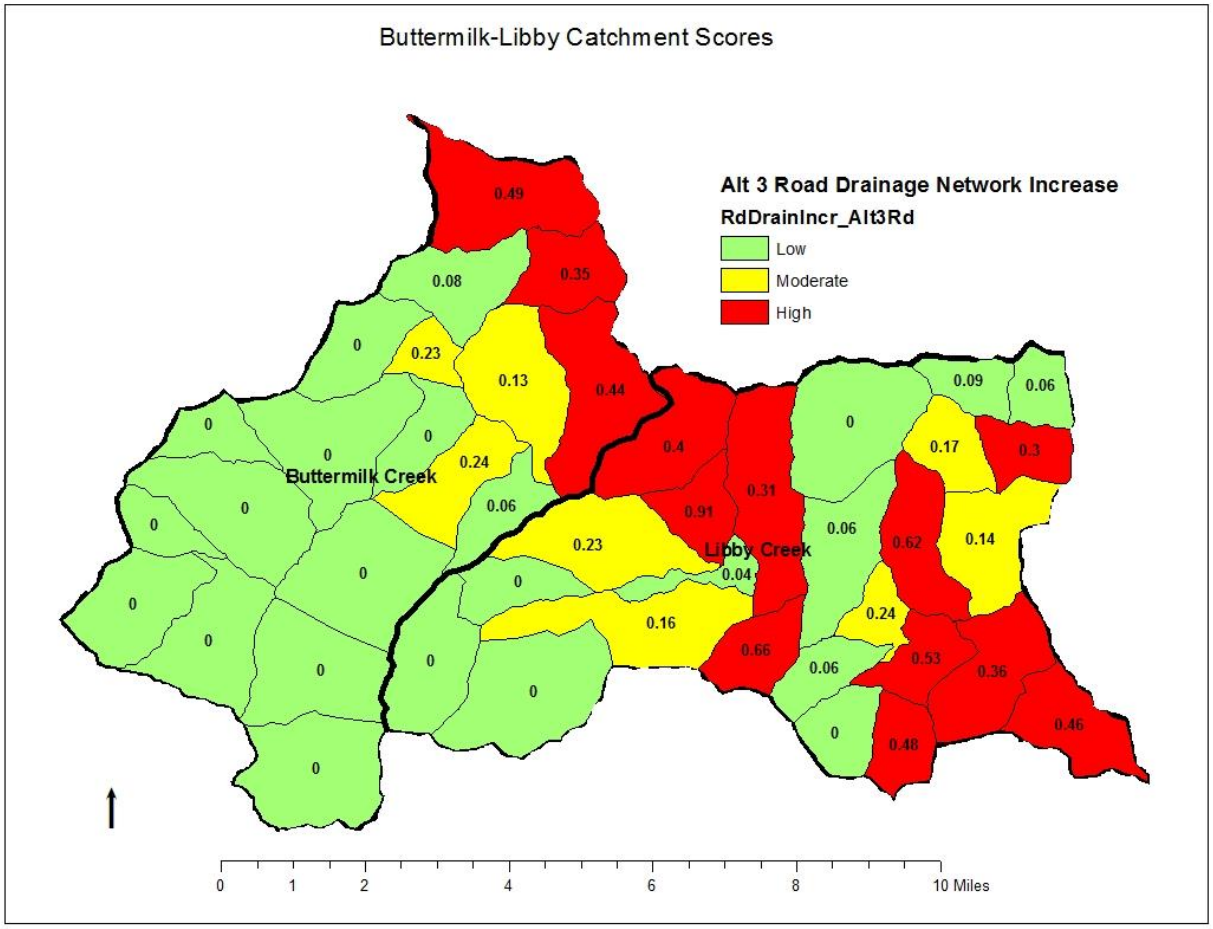
Figure 34. Alternative 3 road density by catchments.



Resource Indicator: Increase in road drainage network

Alternative 3 would reduce the road drainage network by ~41% across the project area. At the sub-watershed scale, Buttermilk would decrease by ~30% and Libby by ~48% (Figure 35). Decommissioning all roads on the west side of West Fork Buttermilk Creek would change one catchment from a high to low rating. In Libby, nine catchments would improve to lower drainage network rankings with the proposed road changes. The additional reduction in road drainage network would result in a minor, beneficial, long-term effect in the Buttermilk sub-watershed and a moderate, beneficial, long-term effect in the Libby sub-watershed.

Figure 35. Alternative 3 increase in drainage network from road system by catchments.



Resource Indicator: Riparian Road Density

Riparian road density would decrease by about 42% across the project area. In the Buttermilk sub-watershed, road density would decrease by ~32% and in Libby ~50% (Figure 36). In Buttermilk, one catchment would change from a high combined density ranking to a low. Libby would have nine catchments drop in combined density rankings. The averaged catchment/riparian road density rankings would decrease in key areas around North Fork and South Fork Libby, Ben Canyon, and Hornet Draw Creeks (Figure 37). The reduction in riparian roads would lead to the greatest reduction in chronic sediment sources across the Libby sub-watershed. Streams within the Libby sub-watershed would realize a moderate long-term improvement to fine sediment levels. Buttermilk would have considerable improvement in the one catchment, but a minor long-term improvement across the sub-watershed.

Figure 36. Alternative 3 riparian road density by catchments.

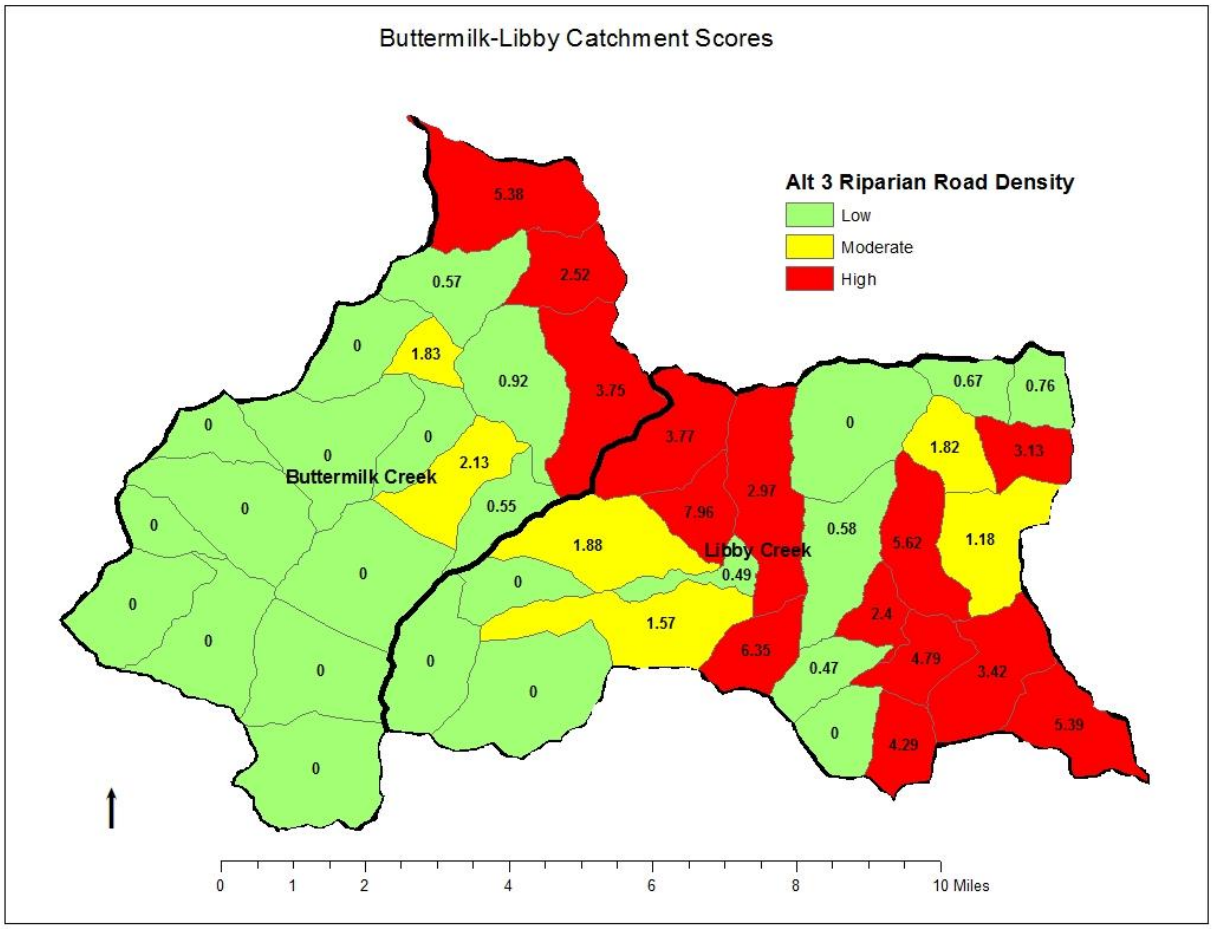
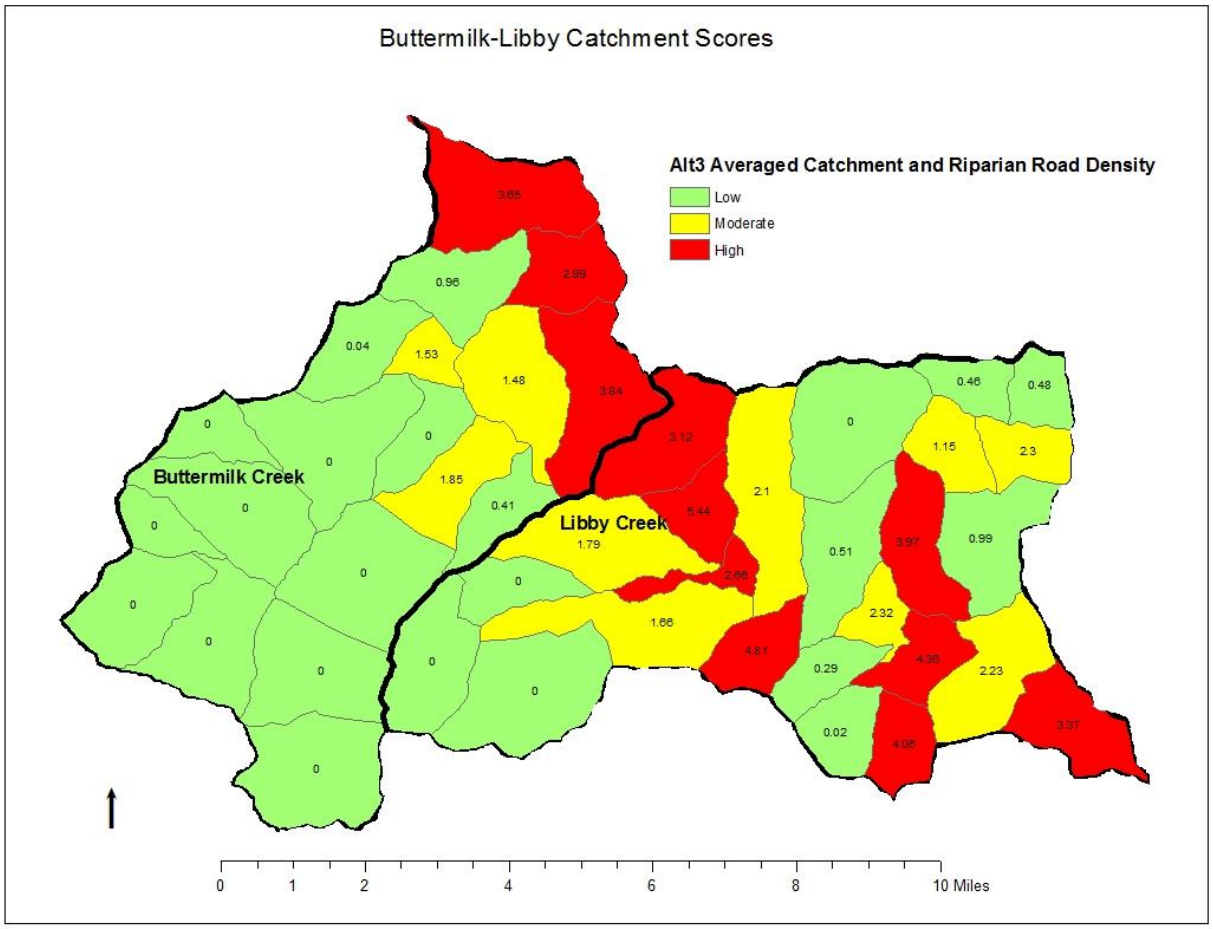


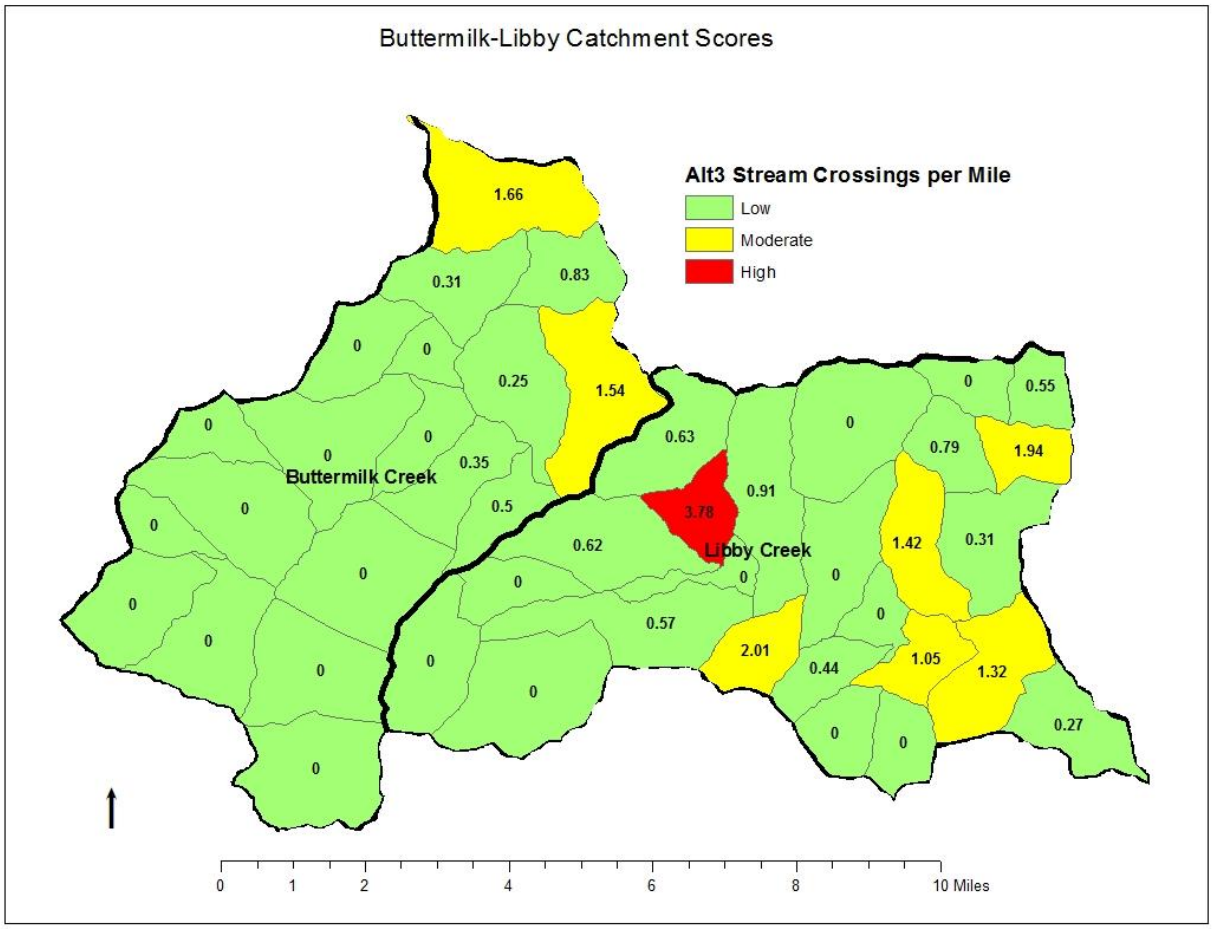
Figure 37. Alternative 3 averaged catchment and riparian road density by catchments.



Resource Indicator: Stream Crossings per Mile

Alternative 3 would remove ~ 52 stream/draw crossings across the project area that includes 8 perennial streams, 30 intermittent streams, and 14 ephemeral draws. Stream crossings per mile density would decrease by about 44% across the project area. Within the Buttermilk sub-watershed stream crossings would drop by 34% and in Libby by ~52% (Figure 38). Two catchments in Buttermilk would go from moderate to low ranking. A temporary crossing would be built over West Fork Buttermilk Creek, on road 4300550, to allow for equipment to access area for decommissioning activities. The temporary crossing would follow applicable BMPs and would be removed after use. Libby sub-watershed would have changes in seven catchments, one going from high to low, one from high to moderate, and five from moderate to low. Buttermilk would see a minor reduction in sediment sources, leading to beneficial, long-term, minor effects; Libby would see a moderate reduction in sediment sources that would create long-term, beneficial, moderate effects.

Figure 38. Alternative 3 number of stream crossings per mile of stream by catchments.



3.3.4.4.2 Cumulative Effects

Spatial and Temporal Context for Effects Analysis: The spatial and temporal boundaries for analyzing the cumulative effects to hydrologic and aquatic resources are identical as those used for Alternative 2.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis: The additional road decommissioning and other road treatments is expected to achieve greater aquatic habitat improvement of reduced sediment levels. Other effects would be the same as Alternative 2.

3.3.4.4.3 Summary of Cumulative Effects

Alternative 3 would have the same effects for vegetation and fuels treatments, harvest related road use, AOPs, stream culvert upsizing, coarse wood placement, and beaver release treatments. See Alternative 2 for details. When combined with past, present, and reasonable foreseeable future actions, the additional road decommissioning, road closure, rock armoring, and hardened ford construction under Alternative 3 would create short-term, negligible to minor,

adverse impacts to water quality and fish habitat and long-term, minor to moderate, beneficial improvements to water quality and at-risk fish habitat.

3.3.4.5 Summary of Effects

Figure 39. Summary of Water Resource Effects for All Alternatives

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)	Alternative 2 (% Change)	Alternative 3 (% Change)
Water Quality (Sediment)	Catchment Road Density	Number of Catchment Rankings Lowered	No Change	**5** (3 High to Moderate, 2 Moderate to Low)	**8** (5 High to Moderate, 3 Moderate to Low)
	Road Drainage Network Increase		No Change	**5** (2 High to Moderate, 3 Moderate to Low)	**10** (2 High to Low, 2 High to Moderate, 6 Moderate to Low)
	Riparian Road Density		No Change	**8** (4 High to Moderate, 4 Moderate to Low)	**11** (2 High to Low, 5 High to Moderate, 4 Moderate to Low)
	Road-stream Crossing Density		No Change	**6** (1 High to Low, 1 High to Moderate, 4 Moderate to Low)	**9** (1 High to Low, 7 High to Moderate, 1 Moderate to Low)
	Ground Cover	Amount of bare soil	No Change	+105 acres	+105 acres
Water Quantity (Base Flow)	Beaver Habitat	Number of beaver habitat enhancement sites	0 sites	6 sites	6 sites
Aquatic Habitat	Stream Channel Complexity	Miles of stream restored	0 miles	8.3 miles	8.3 miles
	Fish Distribution	Miles of accessible habitat increased	0 miles	5.6 miles	5.6 miles
		Number of aquatic passage pipes installed	0 AOPs	8 AOPs	8 AOPs

3.3.5 Consistency Statement

The Regulatory Framework applicable to this resource is detailed in Appendix G. This project is consistent with Forest Plan Standards and Guidelines as follows:

Forest-wide Standards and Guidelines:

- 2-14: Mitigation measures such as rock armoring perennial stream crossings, maintaining no harvest stream buffers, following low intensity underburning intensities in RRs, and isolating the work sites for instream work would minimize short-term sediment impacts. Fine sediment levels would improve once the riparian road work is complete.
- 3-1: The project would protect instream habitat with no-treatment buffers. The restorative road treatments would reduce chronic fine sediment delivery to streams. Aquatic habitat restoration treatments would improve degraded or at-risk habitat indicators.

- 3-2: The project meets this guidance via active and passive means of restoration.
- 3-3: Decommissioning riparian roads would reduce the fine sediment delivery to streams. Fine sediment levels in Libby Creek would be expected to have a net reduction in the long-term.
- 3-5: The project avoids removal of overstory trees within at least 100-feet of any stream. Adding wood to streams would increase wood loading in depleted areas.
- 3-6: See response to 3-5.
- 3-7: All instream treatments would occur during the designated instream work window, which falls during the low flow period and outside of spawning and redd timing.
- 3-8: All new permanent culverts proposed would be capable of passing the 100-year flow event and consistent to the Forest Service-WDFW MOU for hydraulic projects. Bridge replacement across W. Fk. Buttermilk Creek would comply with fish passage requirements.
- 13-2: BMPs and design features would prevent for chemical spills in surface water and minimize stream turbidity levels. See above for sediment reducing measures.
- 13-3: Forest Service National Best Management Practices for Water Quality Management on National Forest System Lands (USDA 2012c) would be used as required protective measures during the development and implementation of all projects

Forest Plan Amendment Effects on Substantive Provisions

To meet Purpose and Needs #2, #3, #4 and #6 identified in Chapter 1 of the EA, vegetation management through thinning would reduce deer winter range cover below Okanogan National Forest Land Resource Management Plan Standard and Guidelines MA14-6A and MA26-6A, requiring a project-specific amendment. The 2012 Planning Rule as amended (36 CFR 219) requires consideration of how such an amendment would affect substantive provisions identified in the Planning Rule. With respect to water resources, the following substantive provisions would be affected by the proposed amendment:

<u>219.8(a)(2)(iii) Water quality, and 219.9(a)(2)(i) Key characteristics associated with aquatic ecosystem types.</u> Thinning as provided by this amendment would cause an adverse, short-term, negligible impact on water quality, a key characteristic of aquatic ecosystems, because commercial haul on forest roads would contribute sediment to streams at road crossings. This project proposes rock armoring at six perennial stream crossings used for summer haul routes in Libby Creek, an effective mitigation that would reduce the amount of sediment contributed to streams to an imperceptible amount; the Watershed Erosion Prediction Project Model (WEPP) predicts that rock armoring would result in an ~80% reduction in sediment production to streams. Prescribed burning may create some patches of bare soil that would have short-term susceptibility to erosion that may contribute imperceptible amounts of sediment to streams until ground cover is re-established. BMPs and design criteria would be used to avoid or minimize impacts to water quality.

Thinning would have beneficial, short- to long-term, minor to moderate effects on water quality because thinning and associated prescribed fire treatments would develop forest vegetation structure, overstory and understory species composition, and spatial patterns that are more likely to withstand insect and disease outbreaks and would be more likely to experience low-severity wildfire behavior and effects with reduced impacts to water quality.

219.8(a)(3). Riparian Areas. Thinning and associated prescribed burning as provided by this amendment would occur in established riparian management zones (Riparian Reserves) and would have beneficial, short- to long-term, minor to moderate effects on streams because thinning in some areas would promote hardwoods, providing more suitable beaver food and habitat and increasing opportunities for successful beaver re-introduction as conducted by Washington State Department of Fish and Wildlife (WA DFW). Successful beaver re-introduction would promote water storage and longer stream flow. Thinning and associated prescribed burning proposed in established riparian management zones (Riparian Reserves) would use design criteria including buffers, retention objectives, and prescribed fire intensity objectives that would provide for maintenance or restoration of the ecological integrity of riparian areas.

219.9(b) Additional species-specific plan components. The federally-listed threatened or endangered species in the project area that would be affected by this amendment include spring Chinook, summer steelhead, and bull trout. Region 6 Regional Forester Sensitive Species that would be affected by thinning as allowed by the amendment include westslope cutthroat and interior redband rainbow trout. Thinning as allowed by the amendment would have an adverse, short-term, negligible effect on habitat for these species because log haul traffic associated with commercial thinning would cross streams on roads and contribute some sediment to streams. However, the amount of sediment would be imperceptible in volume and duration and would not impede recovery of T&E species or conservation of proposed and candidate species. This project proposes rock-armoring at six perennial stream crossings used for summer haul routes in Libby Creek, an effective mitigation that would reduce the amount of sediment contributed to streams to an imperceptible amount; the Watershed Erosion Prediction Project Model (WEPP) predicts that rock armoring would result in ~80% reduction in sediment production to streams. Prescribed burning may create some patches of bare soil that would have short-term susceptibility to erosion that may contribute imperceptible amounts of sediment to streams until ground cover is re-established. BMPs and design criteria would be used to avoid or minimize impacts to aquatic habitat.

Thinning would have beneficial, short to long-term, minor to moderate effects on habitat used by these species because thinning and associated prescribed fire treatments would develop forest vegetation structure, overstory and understory species composition, and spatial patterns that are more likely to withstand insect and disease outbreaks and would be more likely to experience low-severity wildfire behavior and effects with reduced impacts to aquatic habitat.

Northwest Forest Plan Standard and Guidelines

Project type and site-specific S&Gs listed below apply to all RRs as well as any activity potentially degrading RR. The Mission Project's consistency with each S&G is discussed below:

- TM-1: The Mission is consistent with TM-1 due to avoiding most RRs. Where harvest occurs in RRs, the objective is to restore riparian vegetation conditions.
- RF-2: Design features described in Appendix D details the process for minimizing landing construction within RRs. No new road construction would occur within RRs. All road work would be designed and implemented with qualified road engineers. High aquatic risk roads were identified from field work and GIS analysis. Where possible, roads that disrupt hydrologic flow paths and have potential to diver streams were proposed for decommissioning. No new road construction would occur.
- RF-4: All new permanent culverts proposed, as well as the bridge replacement across W. Fk. Buttermilk Cr, would be capable of passing the 100-year flow event and consistent to the Forest Service-WDFW MOU for hydraulic projects, which includes provisions for protecting water quality and aquatic life.
- RF-6: All known fish barrier culverts are proposed for upgrading to fish friendly passage structures.
- FM-1: Reintroduction of low-intensity backing fire along would help increase stand resiliency, restore historic vegetation patchiness and species composition, and promote large and old trees. Deciduous vegetation, shrubs, and down material on the ground in RRs would not be targeted and would be marginally reduced.
- FM-4: See FM-1 above.

Project Consistency with the Aquatic Conservation Strategy Objectives

The Northwest Forest Plan identifies nine Aquatic Conservation Strategy Objectives (USDA and USDI 1994) applicable to projects conducted under NWFP management direction

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape features to ensure protection of aquatic systems to which species, populations, and communities are uniquely adapted.

Altered fire regimes, increased road densities, climate, and the condition of soil types and plant communities affect aquatic systems in project area. Proposed thinning and prescribed fire treatments would compensate for an altered fire regime and restore certain plant communities, contributing to a project objective to restore the function of landscape-scale processes, such as wildfire, in order to protect the complexity and distribution of plant communities (including riparian areas) across the landscape. The Mission Project is expected to maintain and slightly improve the distribution, diversity and complexity of watershed and landscape features.

2. Maintain and restore spatial and temporal connectivity within and between watersheds.

Several culverts create barriers to habitat connectivity in the project area and would be replaced by structures that would allow for full aquatic and riparian species passage. The proposed actions would not create any barriers for fish within the project area.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

Removing culverts through road decommissioning and road closure would eliminate some artificial constraints on the shape of small streams in the project area, which would help restore the physical integrity of these streams. Some activities would result in a minor temporary increase in fine sediment levels within project area streams. Improvements to coarse wood levels would increase channel stability and create more desirable channel conditions. Projects would maintain the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems.

Proposed commercial thinning would maintain shade levels and not affect stream temperature. Most underburn units with perennial RRs use existing roads within the RRs as control lines. The roads lie at least 100 feet from adjacent streams. Active lighting would stop within 100 feet of perennial streams and 25 feet of intermittent streams. Ignitions in RRs would be designed to meet resource objective of retaining 95% of overstory trees, 66% of the understory/shrub layer, and 50% of the surface ground cover/organic material. Fire would be allowed to back towards streams when resource objectives can be met. Vegetation mortality levels would be low. Some localized shade reduction could occur, but would have minor impacts on stream temperatures, especially where listed fish occur, miles downstream. Therefore, proposed prescribed fire treatments would result in an insignificant negative effect to temperature. The proposed projects are expected to maintain water quality necessary to support healthy riparian, aquatic, and wetland ecosystems at the project and watershed scale. See the discussion below for effects to turbidity.

5. Maintain and restore the sediment regime under which aquatic ecosystems were formed.

Thinning within the outer portion of Riparian Reserves would have a low probability of introducing sediment to streams. About 60% of the harvest proposed within RRs would occur over frozen ground with little ground disturbance and no sediment delivery to streams. The other 40% would be optional summer or winter harvest. Protection buffers of at least 100 feet from streams would be applied consistent with Sweeney et al. (2014), to trap ultra-fine sediment from reaching streams. Based on these measures and recent research, little to no sediment delivery would likely occur from commercial thinning units potentially harvested during the summer months. Activities outside of Riparian Reserves, such as tree harvest using mechanical equipment and prescribed burning, would be unlikely to contribute sediment to the streams because the full reserve widths would prevent sediment from reaching streams. Design details that would minimize erosion and sediment movement throughout the units are in Appendix D.

The proposed road maintenance, construction (temporary roads), decommissioning, closure, and log hauling would increase sediment yield. Due to hydrologic connectivity with roads, sediment could reach fish habitat. This increase would last an estimated 1-3 years following treatment. Design Features and Mitigation Measures listed in Appendix D would minimize sediment delivery to streams. Measures like rock armoring perennial stream crossings prior to log hauling and working under dry weather conditions would minimize fine sediment mobilization. The amount of sediment reaching streams, using design features and BMPs would be minor.

Once the road construction, maintenance, and decommissioning sites stabilize and log hauling ceases, the net sediment yield for the Buttermilk and Libby Creek drainages would reduce. The

reduction in sediment delivery to streams, coupled with other efforts across the watershed, would act cumulatively to provide long lasting improvements to watershed health in the project area. At the watershed scale, the short-term increase in sediment delivery and long-term reduction would improve the sediment regime.

6. Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient and wood routing.

The current road network increases the stream drainage network by ~ 30%. Additionally, historic beaver colony were abundant and the wetland habitat they created provided important natural water storage that sustained higher summer and fall base flows. Currently, base flows are reduced due to irrigation withdrawals off National Forest lands.

The proposed thinning, prescribed fire, and road management activities would change the drainage network. Collectively, with the miles of skid trails and firelines, there would be a temporary increase in the drainage network. Most new temporary drainages would be disconnected to the stream network. In the long term, once the skid trails and fire lines recover, the miles of road decommissioning would result in a net decrease in the miles of artificial streams associated with roads from 30 to 44 percent, depending on the amount of road decommissioning selected.

An objective of this project is to improve base stream flow within the Buttermilk and Libby Creek sub-watersheds. Establishing six beaver habitat enhancement sites, in concert with the existing WA DFW beaver reintroduction project, would provide several opportunities for beaver colonization to improve base flows and move towards a more natural flow regime. If successfully occupied, beaver colony sites would function as 'sponges' soaking up early spring runoff and delivering that water from underground storage where it releases slowly, resulting in increased summer and fall flows. Previous beaver release sites in the Methow Valley Ranger District were monitored and documented to show increased water storage and improved summer flows downstream (Pollock et al. 2003).

The negative effects associated with harvest and fuels activities and the associated road work, when considered collectively with the beaver release sites, would remain an insignificant negative affect for a few years, then an insignificant positive effect in the long-term. This project element is expected to maintain instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of nutrient and wood routing.

7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

Existing meadows and wetlands would be protected with the project design features. Releasing beavers at six sites would increase the amount of wetland habitat in the project area. Proposed projects are expected to maintain the timing, variability, and duration of floodplain inundation and water table elevation in meadows, wetlands and floodplain development.

8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

Most Riparian Reserves would be untreated; therefore, the overall current condition would mostly be maintained. The limited amount of commercial and non-commercial thinning and/or underburning (in shrub communities) in Riparian Reserves is designed to restore the species composition and structural diversity of riparian plant communities. This includes forbs, grasses, shrubs and trees; snags, large and old trees and thickets of young trees; rotten logs and newly-downed wood of various sizes. Thinning competing small-diameter Douglas fir from larger riparian trees may improve the long-term supply of coarse woody debris at a few sites. Decommissioning riparian roads would increase the amount of vegetated riparian area. Therefore, the proposed harvest, prescribed burning, and road management would not retard the area from maintaining or restoring species riparian composition and structural diversity of plants capable of providing the above protection and complexity at the project scale.

9. Maintain and restore habitat to support well distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

Riparian Reserves treatments were chosen carefully to restore habitat and riparian function at those sites. A majority of the Riparian Reserve acres remain untreated and riparian dependent species would be undisturbed over about 90 percent of the total RRs in Buttermilk and 80 percent in the Libby Creek sub-watershed. The commercial and non-commercial thinning and underburning (in shrub communities) are designed to restore the species composition and structural diversity of riparian plant communities. Projects are expected to maintain habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

3.4 Soils

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Soil Resource Report by L. Cerise (2016), available in the project record. Reference information is contained in the full specialist report.

3.4.1 Methodology

The analysis area for soils encompasses all land within an individual treatment unit. In general, soils outside the unit boundaries (activity areas) are not expected to be directly, indirectly, or cumulatively affected by this proposal (no harvest or post-harvest equipment will operate off system roads outside the unit boundaries). The Okanogan-Wenatchee Forest Plan determines suitable land (areas suitable for timber management) with the recognition that there are unsuitable land inclusions within this broader designation. The identification of these inclusions and their significance is left to the project level. Determination of suitability within each unit was completed with the premise of “the growing, tending, harvesting, and regeneration of crops of trees…” (NFMA 1976). Physical properties of concern include structure, density, porosity, infiltration, permeability, water holding capacity, depth to water table, surface horizon thickness, and organic matter size, quantity, and distribution. Chemical properties include changes in nutrient cycling and availability. Biological concerns commonly include abundance, distribution, and productivity of the many plants, animals, microorganisms that live in and on the soil and organic detritus.

The proposed treatment units were assessed by field reconnaissance by a professional soil scientist during the spring of 2015 & 2016. GIS data analyses utilized the Okanogan-Wenatchee National Forest Land Survey Inventory (NRCS soil survey), R6 Droughty Soil Index Layer, and the R6 Landtype Association Map.

The proposed treatment units were field reviewed using a walkthrough survey to get an overview of each unit. The surveys identified past management activities, such as timber harvest, that still result in detrimental soil disturbance (DSD). Soil surveys followed guidance provided in the documents listed below for each indicator analyzed.

- The Region 6 Approach to Soils NEPA Analysis Regarding Detrimental Soil Disturbance In Forested Areas – Region 6 Supplement (2500-98-1).
- Forest Soil Disturbance Monitoring Protocol (FSDMP), Volume 1 Rapid Assessment. USDA Forest Service. Gen. Tech. Report WO-82A. September 2009
- Soil –Disturbance Field Guide. USDA Forest Service. National Technology & Development Program. 0819 1815-SDTDC. August 2009.

The soil resource indicators used for analyzing the impact of the proposed alternatives are displayed in **Figure 40**.

Figure 40. Soil Resource Elements, Indicators and Measures for Analysis

Resource Element	Resource Indicator	Measure	Purpose and Need or Key Issue	Source
Soil Erosion	Detrimental Surface Erosion/Mass Wasting	Percent of total unit	P&N #2	Okanogan National Forest Land and Resource Management Plan (LRMP), The National Forest Management Act of 1976, Forest Service Manual (FSM) 2500 Chapter 50, Region 6 Supplement to FSM 2500 (2500-98-1)
Soil Disturbance	Compaction, Rutting, Puddling	Percent of total unit	P&N #2	Okanogan National Forest Land and Resource Management Plan (LRMP), The National Forest Management Act of 1976, Forest Service Manual (FSM) 2500 Chapter 50, Region 6 Supplement to FSM 2500 (2500-98-1)
Site Productivity & Nutrient Cycling	Organic Matter, Coarse Woody Material & Ground Cover	Tons per Acre in each unit	P&N #2	Okanogan National Forest Land and Resource Management Plan (LRMP), The National Forest Management Act of 1976, Forest Service Manual (FSM) 2500 Chapter 50, Region 6 Supplement to FSM 2500 (2500-98-1)

3.4.2 Intensity Level Definitions

Type of Impact:

- Beneficial: de-compaction of soil, re-contouring roads, biomass additions to soil surface, seeding/plantings
- Adverse: excess compaction, rutting >6 in., puddling, removal of organic matter layer, erosion

Duration of Impact:

- Short term: 5-10 years; soil BMPs are designed for soil recovery in the short term
- Long term: 10+ years; if soil BMPs are not followed project impacts to soil productivity could be many decades out

Intensity of Impact:

- None: No impact.
- Negligible: Impacts to soil productivity are not noticed or measurable. No compaction, rutting or displacement of soil organic layer.
- Minor: Impacts to soil productivity are slightly visible/measurable and are not noticeable the following growing season. Platy soil compaction is friable, soil structure retains micro and macro pores and does not impede root growth, rutting is less than 6 in. in depth, and soil organic layer is fully intact.
- Moderate: Impacts to soil productivity are visible/measureable, have up to 50% of the organic matter layer removed, and have measureable impacts such as platy soil structure and rutting, but sustains a diverse plant community multiple years after project implementation
- Major: Impacts to soil productivity are visible/measurable, rutting and compaction exceeds R6 standards, complete or near complete loss of organic matter layer, visible erosion and have measureable impacts decades after project implementation. These types of soil impacts will not sustain a diverse plant community, but rather a monoculture of non-native plants or no plant growth at all.

3.4.3 Affected Environment

Landforms of the project area are comprised of mountain slopes and ridgelines that transition to mid-elevation valley bottoms. Slopes tend to be moderately incised with drainages that empty into the Libby Creek and Buttermilk watersheds. Soils across the project area are derived primarily of volcanic ash over glacial till and glacial fluvial outwash. Volcanic ash from Mount Mazama (Crater Lake, OR) was deposited in the project area approximately 7,000 years ago, followed by more ash depositions from multiple Glacier Peak eruptions starting ~4,500 years ago and a series of Mt. St. Helens eruptions. Physical characteristics of this volcanic ash include low bulk density (0.65 to 0.90), a dominance of silt and very fine sand-sized particles with weak structural development. On north, east, and west aspects the ash forms a distinct horizon (~4 ft.) over a variety of parent materials. On southerly aspects, the ash commonly

occurs as a component of the A horizon (0-12” soil depth) and is generally mixed with the underlying parent material due to geologic erosion.

The primary underlying parent material is glacial till and glacial fluvial outwash. The Cordilleran Ice Sheet overrode the project area as late as 12 to 14,000 years ago and strongly influenced topographic expression (Waitt 1972). This massive ice sheet filled valleys and overrode many of the ridges within the analysis area. Glacial till, which is unconsolidated glacial debris, filled valleys and incised uplands within the area. The rest of the underlying parent material in the area is primarily composed of metamorphic bedrock with igneous intrusions (Stoffel, no date). In glaciated areas, the granitic bedrock has been scoured and abraded by glacial ice which exposed hard, relatively unweathered bedrock. These soils commonly have a high percentage of rock fragments ranging from gravel to boulder in size.

Soil textures range from ashy loams to sandy loams with low to high coarse fragment content. The majority of volcanic ash deposition found in the project area ranges from 10-22 inches over glacial till or glacial outwash. Rock outcrops and talus slopes are common features across the landscape. In some locations open talus slopes are present with little to no soil development. Soils across the steep slopes have formed in voids between the talus rocks. These soils are shallow and in some cases only organic soil and duff material can be found overlying the rock or among the rocks. Inclusions of wetland and riparian soils are found throughout the project area.

Inclusions of open talus slopes were identified in various units and are considered unsuitable lands for timber operations. These talus inclusions typically occupy less than 1 acre and do not contain productive timber stands. Thinning and ground based operations would not occur on these open talus slopes. There may be occasions where skyline yarding corridors pass through these areas in order to reach the portions of units below these areas.

A complete list of dominant landtypes within the boundaries of the treatment are included in the Mission Project Soils Resource Report (Cerise 2016).

Resource Indicator: Detrimental Surface Erosion/ Mass Wasting
Field surveys conducted in 2015-2016 using the FSDMP showed no major signs of erosion in each unit surveyed. DSD was identified in 40 of the proposed commercial treatment units. Existing DSD is within soil quality standards for 26 units and 14 units are at or very near soil management guidelines. DSD was not identified in the remaining 31 treatment units (full list of units and status included in Cerise 2016).

The majority of the erosion observed in the project area has come from roads. No mass wasting was observed during field surveys. Existing levels of detrimental soil erosion in the analysis area is low to moderate due to previous timber/fuels management activities, grazing related impacts (primarily in riparian areas), roads, and some dispersed recreation. Legacy soil disturbance (disturbance that occurred as a result of past activities) forms the foundation of the soil conditions on the landscape today, the existing soil condition. These activities include but are not limited to: timber harvest, grazing, road construction, recreation, shake mills, and fires.

Harvest activities and heavy traffic associated with past shake mills have created long term (>50 years) DSD and is primarily the result of past ground-based yarding. Past harvest consisted primarily of ground based operations with select areas of skyline yarding. Yarding practices prior to the late 1980's often did not adhere to soil protection measures such as operating on frozen soil, slash mats, designated skid trails, and soil moisture limits. Timber was removed from the forest as economically as possible. Soils were compacted and displaced by skidding. Displacement of mineral soil was often considered desirable because trees regenerated well on these sites.

Based on field surveys, soils in previously disturbed areas are recovering in the majority of the project area. Previously displaced areas have redeveloped organic horizons and are developing productive topsoil horizons in most areas. Some areas, such as old landings, burn piles, and major skid trails, exist where minimal organic horizons have developed and mineral soils are vulnerable to erosion or weed colonization. While compaction has longer lasting effects on soil types with fine textures such as clay loams, there are no clay loam soils present in the project area. Compacted sandy loam to loam soils, which are the dominant soil textures across the project, have improved naturally in the surface horizons (approximately 0 to 6 inches). In some cases, subsurface compaction persists 6 to 12 inches below the soil surface. In areas with persistent compaction, soil restoration methods will be applied to break up soil compaction while leaving subsurface roots and rocks in place to prevent soil horizon mixing. Approximately 30% of historic skid trails identified in select treatment units were determined to have root limiting compaction considered to be detrimental to soil function. This is based on soil monitoring during field surveys.

Past harvest/thinning activities occurred in the proposed treatment units. The majority of these units have had entries since 1970. Past vegetation management involved a wide variety of treatments including clear-cutting, shelterwood harvest, and salvage & sanitation treatments. Ground based yarding was noted on continuous slopes exceeding 35% which would not occur during today's logging practices. Machine piling of slash with dozers and mechanical site preparation was observed in the project area; this was a common practice prior to the mid 1980's (Meurisse 1978), but is no longer an acceptable management practice on NFS lands.

Past ground based operations often gave little thought to soils when considering skid trail layout. In 1985, Froehlich showed that designating skid trail locations greatly decreased the areal extent of soil disturbance. When skid trails were established at 100 foot spacing, 11 percent of a unit would be covered in skid trails (Froehlich et al. 1985). By the mid to late 1980's, forest practices were changing to incorporate these findings. For example, skid trails were designated, season of use considered, and the practice of machine piling slash was limited. The Forest has ended the practice of dozer-piling slash, opting for whole tree yarding or underburning of slash. These and other Watershed Best Management Practices (BMPs) along with Forest Plan Standards and Guidelines were developed using this research to manage timber harvest yet sustain site and soil productivity.

Resource Indicator: Compaction, Rutting & Puddling
Evidence of past ground based operations was noted in several units primarily from landings, old skid trails, and mill activity where root limiting soil compaction is still present. Past displacement of organic horizons has not fully recovered in these units. Organic horizons and duff on the old skid trails does not resembled that of adjacent undisturbed areas. Several of the old skid trails cross through talus slopes that have thin organic horizons with little to no mineral soil.

The compaction observed during field surveys was along old skid trails, log landings, stock driveways, and dispersed camping sites. Most of the compaction along skid trails and landings has been reduced from the establishment of grass, forbs, and small diameter trees currently growing on site; except for those units with higher DSD. Stock driveways/paths have compaction along the main travel routes, but grass and forbs were observed growing along and within the path, and no erosion was observed coming from the stock paths.

Resource Indicator: Organic Matter, Coarse Woody Material, Ground Cover, & Nutrient Cycling
The current condition for organic matter and ground cover are within soil management objectives for all units except those with higher DSD. The organic matter layer is at varying stages of decay indicating that organic material is decomposing in-place and that new additions are being added to the topmost layer. Ground cover was present in about 90% of each unit surveyed that accounts for the new additions of organic matter. Observation of varying stages of organic matter decay indicates that nutrient cycling is occurring in the project area. Coarse woody material is generally within range of soil management objectives for each unit surveyed.

Figure 41. Soil resource indicators and measures for the existing condition.

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
Soil Erosion	Detrimental Surface Erosion/Mass Wasting	Percent of total unit	2% (no recent mass wasting observed)
Soil Disturbance	Compaction, Rutting, Puddling	Percent of total unit	4-7% average in each unit
Site Productivity & Nutrient Cycling	Organic Matter, Coarse Woody Material & Ground Cover	Tons per Acre in each unit	Average 2-8 tons/acre in each unit

3.4.4 Environmental Consequences

3.4.4.1 Considered, but not Analyzed in Detail

The resources listed in **Figure 42** were not analyzed in detail.

Figure 42. Soil Resources Considered But Not Analyzed in Detail

Resource	Rationale for Dismissing from Further Analysis
Soil Water Holding Capacity	Lacked time and funding for accurate analysis. Analyzed current conditions for potential conditions through comparable studies.
Total Soil Carbon	Lacked time and funding for accurate analysis. Used general estimates from comparable studies.

3.4.4.2 Alternative 1

3.4.4.2.1 Direct and Indirect Effects

Resource Indicator: Detrimental Surface Erosion/Mass Wasting

The No Action Alternative would not alter the current soil erosion and mass wasting regimes in the project area. Doing no treatments would continue the long-term, adverse, moderate impacts on soil erosion and mass wasting. Erosion from road prisms throughout the project area would continue to some extent in this alternative. Natural and human caused wildfires could affect the project area and cause consumption of the protective layer of litter and duff on the soil surface.

The occurrence of substantial levels of soil erosion and mass movements on the forest has been low where low severity fire has occurred (based on monitoring conducted on the forest). Larger fires and those with moderate or high severity may result in soil erosion and mass movement depending on ground conditions and storm activity (Parrett et al. 2003). Soil erosion occurs where ground cover, duff, and litter are consumed or hydrophobic soil conditions develop. Mass movement occurs primarily in the form of debris torrents within channels following high severity, short duration storm events.

Based on the slope structures and fine fragment content in most of the soils in the project area, erosion and mass wasting potential following a severe fire would be major (based on field observation after the flooding in the Carlton Complex burn area). Colluvial activity may increase in areas where structural support from trees is lost; however, sediment transport would not occur on the rocky slopes. Loss of productive organic horizons through fire consumption would be of greater importance for soil productivity.

Resource Indicator: Compaction, Rutting & Puddling

Doing no treatments would continue the long-term, adverse, major impacts on soil compaction in the identified areas. Alternative 1 would not lead to direct detrimental soil disturbances in the project area. However, current soil compaction in 14 units exceeds R6 soil standards and this alternative would do nothing to reduce the long-term legacy compaction found in the project area.

Resource Indicator: Organic Matter, Coarse Woody Material, Ground Cover, & Nutrient Cycling

Doing no treatments would continue the long-term, beneficial, impacts on soil organic matter and nutrient cycling. The No Action Alternative would allow all standing trees (dead and alive) over time to shed needles and fine branches that would accumulate on the soil surface. Eventually, trees would fall to the ground, providing coarse wood for decomposition into the soil. Soil organisms would slowly decompose the organic materials, adding beneficial humus to the

soil. Nutrients associated with this material would slowly become available for plant growth. This process would continue until another major disturbance, such as fire, consumes or partially consumes the accumulated litter, duff, and woody material.

Long-term effects on soil health and productivity are likely to be relatively small from future fires that are within the historic range of variability (Reinhardt et al. 2001). Fire severity exceeding the historic range could have detrimental effects on soil productivity and health through the oxidation and loss of soil organic matter and associated soil biota, as well as through accelerated rates of erosion (Campbell et al. 1995; Harvey et al. 1987; Harvey and Sala 1988). Optimal levels account for the historic range of variability in fuel loadings, fire responses to these loadings and to climatic factors in the past few hundred years of the pre-settlement period, as well as considering the risks to resources and firefighters (Reinhardt et al. 2001).

Microorganisms would continue to populate the soil, contributing towards site productivity through nutrient cycling and development of soil structure aggregates in areas of poorly developed mineral soils. The occurrence of severe wildfire may alter soil microbial communities by super heating mineral soils and consuming organic matter necessary for microorganism functions. But in all, nutrient cycling would remain at current levels with a no-action alternative.

3.4.4.2.2 Summary of Effects

The No Action Alternative (Alternative 1) would continue to have long-term, adverse, moderate impacts on soil erosion and mass wasting in the project area, and there would continue to be long-term, adverse, major impacts on soil compaction in the identified areas. Alternative 1 would continue the long-term, beneficial, impacts on soil organic matter, coarse woody debris and nutrient cycling found throughout the project area.

3.4.4.3 Alternatives 2 and 3

Alternatives 2 and 3 include the same proposed actions with the addition of more road decommissioning and stream enhancements. Because of this, the effects for both alternatives are analyzed together.

3.4.4.3.1 Effects

Figure 43. Soil Resource Indicators and Measures for Alternative 2

Resource Element	Resource Indicator	Measure	Alternatives 2 and 3
Soil Erosion	Detrimental Surface Erosion/Mass Wasting	Percent of total unit	5%
Soil Disturbance	Compaction/Rutting/Puddling	Percent of total unit	7-10%
Site Productivity & Nutrient Cycling	Organic Matter, Coarse Woody Material & Ground Cover	Tons per Acre	5-20 tons/acre

Resource Indicator: Detrimental Surface Erosion/Mass Wasting
Following soil design features will result in adverse, short-term, negligible detrimental surface erosion from management activities. Forests generally have very low erosion rates unless they are disturbed in a manner that exposes bare soils to the erosive energy of water and wind. Management caused disturbances include prescribed fire, road maintenance, harvesting, and post-harvest operations. Soil erosion in harvest units is diminished by minimizing the amount of bare soils created by disturbance (Clayton and Megahan 1997; Robichaud and Hungerford 2000). The practices that maintain soil productivity (such as leaving organic material on the soil surface, reducing the area impacted by skid trails, and maintaining hydrologic function) all reduce the risk of soil erosion (Region 6 BMP's). In addition, implementing specific erosion control measures such as water bars, placing slash on bare soils, and vegetating disturbed soils conserve the soil resource (Mitigations, Design Criteria).

The volcanic ash mantle is highly susceptible to erosion, however, the mitigation measures and BMPs are designed to leave the organic layer and vegetation intact thus minimizing or all together eliminating any erosion that would take place from management activities. The high coarse fragment content of the other soils found in the project area provides armoring against erosion. In some places across the project area, talus slopes and high surface rock content would prevent overland flow.

Prescribed Fire: The prescribed burning in the project area should not produce any new or foreseeable soil erosion. Prescribed fire is generally low to moderate burn temperatures that are done in the spring/fall when soil moisture is present and soil temperatures do not overheat causing soil hydrophobicity that leads to erosion. When applicable, Minimum Suppression Techniques (MIST) would be used to reduce soil impacts from fire line construction.

Risk of mass movement from prescribed fire is also very low. Prescribed fire is typically completed when soil moisture is high (greater than 80 percent) and weather conditions are cool and humid. Intense heating of the soil and complete consumption of organic soil horizons typically does not occur except in select cases where a log or accumulated fuel pile burns for an extended period of time. The probability of these small areas of disturbance altering slope stability is very low. It should also be noted that mature trees are typically not affected during prescribed burning. The rooting systems of these mature trees would remain intact to provide surface stability.

System & Temporary Roads: The construction of temporary roads does have a major impact on the soil resource. However, if soil BMPs/design criteria are followed, these temporary roads will have sufficient ground to minimize soil erosion and promote native plant growth by seeding and slashing. There is always some soil erosion from the road prism throughout the year. The proposed road maintenance will have initial soil disturbance during implementation. Soil BMPs will be used during road maintenance to minimize soil erosion from the road prism. The end goal of the proposed road maintenance is to reduce chronic sedimentation points along forest system roads.

Summer Ground Based Harvest Effects: Summer ground-based harvest will reduce ground cover on heavily used landings, skid trails, and near landings. An estimated reduction of ground

cover up to ten percent in the proposed ground based units has been used for soil disturbance analysis in this project. Old skid trails remaining from past timber management operations are present in some of the ground based units. Most, but not all, old skid trails have naturally rehabilitated and do not currently have detrimental soil conditions. These old trails are difficult to locate in many areas. In order to minimize disturbance to soils that have never been ground based yarded, the old trails that are easily identifiable will be reused to the extent feasible.

The main soil concern for ground based yarding in the project area is displacement of thin organic horizons and the displacement of the volcanic ash mantle. On lightly used trails (one or two passes) ground cover is not anticipated to be reduced along the entire trail length. Compaction of mineral soils may occur but is likely to be buffered by soil BMPs. Constructing water bars, creating brush sediment traps, or seeding/planting forbs, grasses, or shrubs, will hasten groundcover recovery and reduce soil erosion and movement of soil off-site (Soil BMPs). Disturbed vegetation would re-grow in less than five years except where there is root kill.

Skyline Harvest Effects: Groundcover in skyline corridors would be reduced approximately five to ten percent as a result of choker setting, cables, and removing logs from the site (Clayton and Kennedy 1985). In many cases, the displaced groundcover along the corridor occurs in small patches. These small areas (less than 100 square feet) of displacement are not considered DSD. Ground cover reduction would only occur along the corridor where log suspension is limited and numerous yarding passes occur. At landings, there would be additional reduction in groundcover due to equipment operations and corridor convergence. Full suspension of logs will be required on steep slopes with shallow soils within the project area.

Loss of groundcover in the corridors and landings will be lessened through full suspension of logs during yarding and ceasing of operations if wet conditions are encountered. Corridors and landings will have erosion control treatments following logging and site prep activities. Treatments included in the timber sale contract would include construction of water bars and placing of slash on bare soils in the corridors and landings where deemed necessary by the soil scientist and timber sale administrator. In the long-term, (greater than 10 years) it is anticipated that groundcover would become re-established in displaced areas, with or without post-activity rehabilitation. Groundcover recovery would be achieved with needle cast and vegetation re-growth.

The shallow soils overlying talus slopes are not conducive to surface mass movements. The proposed thinning treatments would not affect surface stability of these shallow soils (using full log suspension) and talus slopes. Mass movements are only likely in the event of a deep seated geologic failure. In summary, the risk of landslide initiation as a result of forest thinning in the action alternatives is very low.

Resource Indicator: Compaction/Rutting/Puddling
Following soil design features will result in adverse, short-term, minor detrimental soil compaction, rutting, and puddling from management activities. The potential for compaction with ground-based equipment on the ash cap soil is moderate to high, but if soil BMPs are implemented new compaction would be minor. In addition, commercial thinning would be required under winter conditions in some areas to prevent further soil disturbance. Winter soil

conditions allow for protection of detrimentally impacted soils from past management while allowing the area to be thinned by mechanized harvesters to achieve project goals. If the purchaser can implement a harvesting plan that meets the winter soil management objectives then snowplowing and hauling would not take place in winter. The existing compaction of major intensity from past land use is of greater concern. These units have soil compaction conditions that limit water infiltration and storage in the soil profile, promotes invasive plant species while reducing native vegetation from poor soil conditions, and reduced nutrient cycling due to organic matter reduction from poor plant growth. Soil productivity in these relatively young ash-cap soils is dependent on the organic soil horizons for nutrient cycling and water holding capacity.

Alternative 3 would increase soil disturbance through more road decommissioning. However, road decommissioning breaks up soil compaction, re-contours the road to natural slope, and restores soil water infiltration and storage. We expect a temporary moderate disturbance initially, but using soil BMPs the soil will start on a path toward natural recovery.

Resource Indicator: Organic Matter, Course Woody Material, Ground Cover & Nutrient Cycling
Following soil design features will result in beneficial, long-term, positive impacts for soil organic matter, woody material, and nutrient cycling. The activities proposed are designed to leave a variety of organic matter on the site. The practice of leaving organic matter on site provides for microbial populations which help maintain site productivity (Harvey et al. 1994). Vegetation and organic matter protects the soil surface from raindrop impact, dissipates energy of overland flow, binds soil particles together, and dampens soil temperature extremes and daily fluxes. Studies have found that 60 percent effective ground cover reduced sediment movement substantially and 30 percent ground cover reduced erosion by half compared to bare soil (Robichaud and Hungerford 2000). Logging slash will add to effective ground cover until fine logging slash decomposes over several decades (Clayton and Kennedy 1985).

All harvest prescriptions would leave a portion of the existing stand on the site. Yarding will be done over a slash mat leaving branches with green biomass on-site contributing to long-term site productivity. Coarse woody material (material greater than 3 inches in diameter) would be left from designated leave trees, both standing and down, and from breakage of limbs and broken tops that will occur during harvest. While coarse wood is defined as material greater than 3 inches in diameter, by leaving larger sized, faster growing trees that will eventually die, becoming snags and then down coarse woody material, the treatments are designed to provide future coarse wood greater than 15 inches in diameter. Large coarse wood persists for longer durations and provides greater benefits to soil development than smaller coarse wood. Large coarse wood is also much less of a concern for fire management. Following the treatments, the stands would be capable of producing large coarse wood at a faster rate for soil development than current conditions. To the extent feasible, the largest coarse wood (snags or logs) would be left on-site to satisfy coarse woody material requirements for each treatment unit. Silvicultural prescriptions would account for additional trees that will be required for future coarse wood recruitment in the thinned stands.

The amounts of coarse wood listed in **Figure 44**, for each Fire Group would maintain future soil productivity. The proposed commercial and non-commercial thinning treatments are anticipated

to leave slash on the ground through the winter and into late summer/fall before prescribed burning would be completed. This would provide opportunity for the nutrients in the slash to be leached into the soil.

Figure 44. Coarse Woody Material (CWM) Requirements for soil productivity.

Fire Group	CWM
2 and/or 4 = Warm, Dry Ponderosa Pine and Douglas-fir Habitat Types	5 to 10 tons/acre
5, 6 = Cool, Dry and Moist Douglas-fir Habitat Types	10 to 20 tons/acre
7, 8, and/or 9 = Cool Lodgepole Pine and Lower Subalpine Fir Habitat Types	8 to 24 tons/acre

Any increase in groundcover and/or fine logging slash through harvest may be offset by fuel treatments. Fuels treatments may reduce the amount of organic matter and groundcover in the short-term (5-10 years after treatment) through the use of prescribe fire. In the long-term (greater than 10 years), re-growth of vegetation and annual needle drop would provide groundcover and leaf and litter material necessary for soil organic matter development.

The status of other nutrients is unknown although there are no site indicators which would point to a problem with nutrient availability or cycling in the units. Removal of potassium in whole tree harvests is modest in comparison to soil reserves according to (Jurgensen et al. 1981). Tree growth and ground cover is within the range expected for the site conditions.

Page-Dumroese et al. (2000) found that relatively small levels of disturbance (less than 15 percent of the area) resulted in relatively small losses in carbon, nitrogen, and cation exchange capacity (CEC), ranging between 1 to 13 percent of the available pools. They concluded that at these levels of loss, current soil quality guidelines appear to be adequate. It must be noted that this is based on initial research from the Long-term Site Productivity Project (LTSP) and results may change as more data is accumulated in future years.

Fire suppression in Ponderosa pine has resulted in a build-up of forest litter and accumulation of organic matter (DeLuca and Zouhar 2000). DeLuca's research has shown the positive benefits of reducing fuel loading and renewing the growth of desirable understory plants through the use of fire or harvest or a combination of both. Ponderosa pine communities commonly accumulate little inorganic nitrogen in mineral soil because of the slow decay rates and rapid uptake by plants and microorganisms. In addition, limited quantities of nitrogen may be available due to the accumulation of organic matter composed of woody residue, naturally low in nitrogen. Wildfire and prescribed fire release plant available nitrogen, however a first entry of high severity wildfire may result in root kill and overall reduction in nitrogen mineralization potential.

DeLuca (DeLuca and Zouhar 2000) found prescribed fire following a selection or shelterwood harvest to have a short-term increase in mineral nitrogen followed by a long-term decline in available nitrogen. This may seem like a negative impact of fire reintroduction; however, the reduced stand density has a lower nitrogen demand. In addition, the Nitrogen: Potassium ratio would be in better balance increasing the trees resistance to disease and insects.

Retaining limbs and branches on site over the winter provides for nutrient leaching into the soil (Palviainen et al. 2004). They found that there was little leaching of nutrients from live or dried needles immediately after harvest. However, after 3 months of decomposition he noted appreciable nutrient releases. Some of these nutrients may not be available to the remaining stands as organisms in the forest floor use them during decomposition.

By maintaining organic matter and ground cover on at least 80 percent of the site, nutrient cycling and availability would not be altered. This is supported by the study results described in Appendix A in Cerise (2016). The mitigations and Region 6 soil quality guidelines are prescribed to achieve this desired outcome. Localized losses may occur at landings or where severe fire occurs.

3.4.4.3.2 Cumulative Effects

Spatial and Temporal Context for Effects Analysis

For the soil resource, the area of consideration for cumulative effects is specific to sites where treatment would occur since effects on soil are site specific. Soil erosion (including mass failure) is an exception. Soil erosion is discussed as sediment transport on a watershed scale in the Water Resource report (Shull and George 2016) in the project file.

For past, present, or future activities to overlap in time, the effects on soils from the activities must overlap. Soil physical changes (detrimental compaction, detrimental displacement, detrimental erosion, severe burning, and puddling) can persist in the landscape for greater than 10 years following management activities. Biological soil conditions change quicker, for example re-vegetation occurs within 5 years (under most situations) and organic matter begins to rebuild in 10 years but may take greater than 50 years to reform humus. Time discussions will look back to at least the 1980's until present, which cover both the physical and biological aspects of the soil.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

The past and present conditions were analyzed for in the Existing Condition section. Past harvest activities and past wildland fires are considered part of the existing condition and discussed in the Affected Environment section of this report.

In consideration of the list of past, present and future actions, those that have effects that overlap in time and space with this project for the soils resource include: grazing, dispersed camping and off-road vehicle use. Other activities such as road maintenance, firewood collection, and other past projects have occurred outside unit boundaries.

Figure 45. Soil Resource Indicators: Cumulative Effects

Resource Element	Resource Indicator	Measure	Alternatives 2 and 3	Past, Present, and Future Actions	Cumulative Impacts
Soil Erosion	Detrimental Surface Erosion/Mass Wasting	Percent of total unit	5%	1-3%	6-8%
Soil Disturbance	Compaction/Rutting/ Puddling	Percent of total unit	7-10%	1-3%	8-13%

Site Productivity & Nutrient Cycling	Organic Matter, Coarse Woody Material & Ground Cover	Tons per Acre	5-20 tons/acre	5-10 tons/acre	10-20 tons/acre

Resource Indicator: Detrimental Surface Erosion/Mass Wasting
Cattle grazing and dispersed camping has the potential to affect the project area but the project design criteria will limit any additional surface erosion to less than 1%. Dispersed camps may be located along the roads and adjacent to or on the edge of harvest units. Multiple dispersed camps were noted during the field review. New dispersed recreational and hunting camps may be located along the roads and adjacent to or on the edge of units.

Resource Indicator: Compaction, Rutting, Puddling
Although the amount of future disturbance caused by cattle grazing, dispersed camping, and off-road vehicle use can vary greatly, monitoring suggests there could be a 1-3% increase in soil disturbance in the project area.

Resource Indicator: Organic Matter, Coarse Woody Material, and Ground Cover
Future site productivity & nutrient cycling can be enhanced by proper grazing techniques. A positive growth response from native vegetation is a good indicator of enhance site productivity. Future dispersed camping & off-road vehicle use can strip away ground cover and organic matter leaving exposed, bare soil. These exposed soil areas can be depleted of nutrients and colonized by non-native plant species that disrupt the nutrient cycling of a particular area.

3.4.4.4 Summary of Effects

Following soil design criteria, Alternatives 2 and 3 would have long-term, beneficial, moderate impacts on soil erosion and mass wasting in the project area, and there would be long-term, beneficial, moderate impacts on soil compaction in the identified areas. Alternatives 2 and 3 would continue the long-term, beneficial, impacts on soil organic matter, coarse woody debris and nutrient cycling found throughout the project area.

Figure 46. Soil Resource Indicators and Measures Summary for All Alternatives

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)	Alternatives 2 and 3
Soil Erosion	Detrimental Surface Erosion/Mass Wasting	Percent of total unit	2% (no recent mass wasting observed)	5%
Soil Disturbance	Compaction Rutting Puddling	Percent of total unit	4-7% average in each unit	7-10%
Site Productivity & Nutrient Cycling	Organic Matter, Coarse Woody Material & Ground Cover	Tons per Acre	Average 2-8 tons/acre in each unit	5-20 tons/acre

3.4.5 Consistency Statement

The proposed actions, design criteria, and mitigation measures are in compliance with the Okanogan National Forest Land and Resource Management Plan (LRMP) standards and guidelines 13-9 and 13-10 by reducing the amount of soil displacement, compaction, and puddling. To comply with National Forest Management Act of 1976, the Chief of the Forest Service has charged each Forest Service Region with developing soil quality standards for detecting soil disturbance and indicating a loss in long-term soil productivity where it occurs. Soil standards are built into the Okanogan National Forest LRMP. Forest Service Manual 2500 Chapter 50 establishes the framework for sustaining soil quality and hydrologic function while providing goods and services outlined in forest and grassland land management plans.

The Region 6 Supplement to Forest Service Manual 2500 (2500-98-1) outline additional policy to maintain or improve soil and water quality. The proposed actions and design criteria are in compliance with all Region 6 policies including improvements to soil compaction, puddling, displacement, and burned soils.

Forest Plan Amendment Effects on Substantive Provisions

To meet Purpose and Needs #2, #3, #4 and #6 identified in Chapter 1 of the EA, vegetation management through thinning would reduce deer winter range cover below Okanogan National Forest Land Resource Management Plan Standard and Guidelines MA14-6A and MA26-6A, requiring a project-specific amendment. The 2012 Planning Rule as amended (36 CFR 219) requires consideration of how such an amendment would affect substantive provisions identified in the Planning Rule. With respect to soils, the following substantive provisions would be affected by the proposed amendment:

219.8 (a)(2)(ii) Soils and soil productivity. Thinning on up to 746 acres that would reduce deer winter range cover below S&Gs would have adverse, short-term, minor effects on soils and soil productivity because it would include some commercial thinning that uses machinery that would compact and/or displace soil as previously discussed. These effects would be mitigated using soil BMPs (such as operating over frozen ground, operating on slash mats, etc.) that are designed to keep soil disturbance within Forest and R6 soil management objectives. Thinning would create beneficial, long-term, moderate effects on soil productivity because it would leave a variety of organic matter on the site that would help maintain site productivity (Harvey et al. 1994), protect the soil surface from raindrop impact, dissipate energy of overland flow, bind soil particles together, and dampen soil temperature extremes and daily fluxes. Coarse woody material (material greater than 3 inches in diameter) would be left from designated leave trees, both standing and down, and from breakage of limbs and broken tops that will occur during harvest operations. While coarse wood is defined as material greater than 3 inches in diameter, by leaving larger sized, faster growing trees that will eventually die, becoming snags and then down coarse woody material, the treatments are designed to provide future coarse wood greater than 15 inches in diameter. Large coarse wood persists for longer durations and provides greater benefits to soil development than smaller coarse wood. Large coarse wood is also much less of a concern for fire management. Following the treatments, the stands would be capable of producing large coarse wood at a faster rate for soil development than current

conditions. (Froehlich et al. 1985; Kimsey et al 2015; McNabb et al 2001; Meurisse, R.T. 1978; Dumroese et al 2009).

3.5 Vegetation

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Vegetation Report by J. Daily (2016), available in the project record. Reference information is contained in the full specialist report.

3.5.1 Methodology

The Restoration Strategy (USDA 2012a) outlines the analysis process used to evaluate landscape conditions and assess whether landscape characteristics including forest vegetation composition and structures have departed from historic and/or future ranges of variability. The process involves photo interpretation conducted by Forest Service personnel with local knowledge of the project area to identify multiple vegetation and landscape attributes in each of the two sub-watersheds in the project area: Buttermilk Creek and Libby Creek. Photo interpreted data was field verified for accuracy in portions of both sub-watersheds prior to data analysis. The Ecosystem Management Decision Support (EMDS) modeling tool (EMDS 3.0.2; Reynolds and Hessburg 2005) used these data to evaluate existing landscape and patch-level characteristics and trends separately for each sub-watershed. EMDS was used to compare the current conditions to a range of historical and future reference conditions for each sub-watershed to give insights into how dry and moist forest vegetation composition and structure have changed and how they are likely to change in the future with a predicted warmer and drier climate.

In this analysis, forest structure classes defined as old forest multistory (OFMS), old forest single story (OFSS), stem exclusion closed canopy (SECC), stem exclusion open canopy (SEOC), stand initiation (SI), understory reinitiation (UR), and young forest multistory (YFMS) (O'Hara et al. 1996; Hessburg et al. 2000) are the primary characteristics used to assess how dry and moist forest vegetation composition and structure has changed from 80th percentile values for the historical range of variability (HRV) and future range of variability (FRV). The HRV and FRV for this project, were developed from photo interpreted and modelled data collected from mid-1950s aerial photos. Dry forest is defined as hot, warm, or cool dry sites where ponderosa pine or Douglas-fir is the dominant climatic climax tree species. Moist forest is defined as cool mesic sites where Douglas-fir or subalpine fir are the dominant climatic climax tree species. Structure classes describe how forest vegetation develops over time from the stand initiation stage to intermediate successional stages (including stem exclusion closed canopy, stem exclusion open canopy, understory reinitiation, and young forest multistory) and eventually to later successional stages including old forest multistory and old forest single story. The amount and arrangement (collectively referred to as pattern) of structure classes is considered to be an important indicator of landscape condition (Reynolds and Hessburg 2005) in the landscape evaluation and restoration process.

Where 50% or more of an EMDS vegetation polygon would be affected by treatment, structure classes were reclassified based on estimated effects of the sum of proposed vegetation and fuels management treatments applied within the polygon. The resulting post-treatment data sets for each sub-watershed were modeled by EMDS and evaluated to determine whether the proposed treatments and locations would degrade, maintain, or improve the amount and arrangement of dry and moist forest structure classes when compared to the desired range of variability. Sensitivity analysis of using a 50% or greater treatment threshold for reclassifying vegetation polygon post-treatment structure classes indicates that this method may have overestimated treatment effects (size of the treatment foot print) compared to the actual number of acres treated by approximately five percent in the Libby Creek sub-watershed. This difference is equivalent to approximately one percent of the total Libby Creek sub-watershed area. Sensitivity analysis indicates that the method used may have underestimated treatment effects by approximately one half of one percent compared to the actual number of acres treated in the Buttermilk Creek sub-watershed. These discrepancies were ignored in this analysis.

A small portion of the project area (205 acres) lies outside of the Buttermilk and Libby Creek sub-watersheds, but within the greater Twisp River watershed. This area was added to the project at the request of adjacent residents in the Buttermilk Firewise Community, and is referred to in this analysis as the Buttermilk Annex. The purpose of treatments in this area is based on the need to reduce fire hazard to the WUI, not maintenance and restoration of forest vegetation composition and structure. This portion of the project area was not analyzed with EMDS because it comprises such a small portion of the Twisp River watershed (less than one percent) and proposed forest vegetation treatment effects would be immeasurable in the context of landscape level restoration objectives.

Resource Indicator: The amount and arrangement of dry and moist forest vegetation structures compared to the desired range of variability

EMDS was used to classify dry and moist forest structures in each sub-watershed into OFMS, OFSS, SECC, SEOC, SI, UR or YFMS classes. Each structure class in the dry and moist forest types was measured by the percentage of the landscape to indicate the overall amount on the landscape and by average patch size to indicate the arrangement of structure classes on the landscape. Current conditions in each sub-watershed were evaluated independently with HRV and FRV reference conditions based on the ecological subregion (ESR) to which they are assigned. ESRs are comprised of areas (sub-watersheds) with similar climate, geology, topography, aquatic characteristics, and disturbance history (Hessburg et al. 2000). The FRV (Gärtner et al. 2008) was developed to provide insight as to how forest vegetation in the sub-watersheds may be affected by a changing climate. FRV reference conditions for a given sub-watershed are based on HRV reference conditions of the next (not necessarily geographically located) environmentally warmer and drier ESR. This is a conservative approach for estimating climate change, and it may underestimate the FRV if the degree of climate change is more severe than indicated by the next warmer and drier ESR.

The desired values for the amount and arrangement of dry and moist forest structure classes in this analysis were determined by finding where the HRV and FRV overlap; this intersection is

called “the desired range of variability” (DRV) for this analysis. One key premise of the Restoration Strategy, which is based on current knowledge of existing and anticipated future environmental conditions, is that maintaining and restoring forest vegetation conditions to levels that are within ranges where the HRV and FRV overlap will provide for more sustainable and resilient forest ecosystems. Landscape prescriptions for dry and moist forest structure in the Buttermilk Creek and Libby Creek sub-watersheds were developed based on the need to maintain the amount and arrangement of structure classes within this intersecting range, or to move the amount and arrangement of structure classes closer toward the intersecting range where they are outside of (departed from) these values. Detailed descriptions of sub-watershed landscape prescriptions and processes used to develop them are provided in Churchill 2016 and Churchill 2015. Potential vegetation treatments, including timber harvest and non-commercial thinning treatments, were identified to maintain or change the amount and arrangement of dry and moist forest structure classes based on departures from desired ranges of variability. Treatment locations to apply the landscape prescriptions were developed in ArcGIS based on field reconnaissance, operational feasibility, discussion with resource specialists, and public input.

Resource Indicator: Forest patches with large and medium size trees
EMDS modeling of photo interpreted data was used to characterize the presence of large and medium size trees in vegetation polygons (patches) in the entire Buttermilk Creek and Libby Creek sub-watersheds in the following manner:

- Medium = overstory trees 16 inches to 25 inches diameter at breast height (DBH).
- Large = overstory trees larger than 25 inches DBH with understory trees smaller than 16 inches DBH.
- Large and medium = large size overstory trees (> 25 inches DBH) with medium size understory trees 16 inches to 25 inches DBH.

Estimated effects of implementing the proposed vegetation management treatments indicated that there would be no measurable difference from existing and post-treatment conditions regarding the percentage of the landscape and average patch size of forest patches with medium, large, or large and medium size trees in the Buttermilk Creek and Libby Creek sub-watersheds. The total acreage of treatment to maintain and restore large trees in EMDS vegetation polygons (patches) with medium, large, and large and medium size trees was used to measure the effects of alternatives in each sub-watershed.

Resource Indicator: Western spruce budworm vulnerability compared to the desired range of variability
Using EMDS, Western spruce budworm vulnerability was classified into three categories (high, moderate, or low) based on site quality, host abundance, canopy structure, stand density, host age, patch vigor, and host patch connectivity of vegetation polygons (Hessburg et al. 1999, USDA 2012b). This rating is used to evaluate how vulnerable a landscape is to the propagation of western spruce budworm and shows how insect habitat has changed over time in its amount and configuration. Each vulnerability class was measured by the percentage of the landscape to indicate the overall amount on the landscape. Average patch size and patch density were not included in this analysis because there was little or no detectable difference between current

and estimated post treatment conditions for these metrics in all vulnerability classes in both sub-watersheds, thus providing no meaningful differences to compare the alternatives analyzed. Current conditions in each sub-watershed were evaluated independently and compared with HRV and FRV reference conditions based on the ecological subregion (ESR) to which they are assigned.

Resource Indicator: Forest vegetation vulnerable Douglas-fir bark beetles
EMDS modeling of photo interpreted data was used to characterize the vulnerability of vegetation polygons to infestation by the Douglas-fir bark beetle in each sub-watershed. Douglas-fir bark beetle vulnerability was classified into three categories (high, moderate, or low) based on site quality, host abundance, canopy structure, stand density, host age, and host patch connectivity of vegetation polygons (Hessburg et al. 1999, USDA 2012b). This rating is used to evaluate how vulnerable a landscape is to the propagation of Douglas-fir bark beetle and shows how insect habitat has changed over time in its amount and configuration. Each vulnerability class was measured by the percentage of the landscape to indicate the overall amount present on the landscape.

Estimating the change in Douglas-fir bark beetle vulnerability based on treatment effects is complex, and the methods considered yielded little or no detectable difference between existing and post treatment EMDS modeled values. Based on professional judgement, it was determined that these methods underestimated treatment effects and using EMDS generated data would not accurately describe meaningful differences between alternatives. Acres treated to reduce Douglas-fir bark beetle vulnerability in each vulnerability class will be used in this analysis to measure the effects of alternatives.

Resource Indicator: Forest vegetation vulnerable to dwarf mistletoe infection
EMDS modelling was not used directly to estimate and measure forest vegetation vulnerable to Douglas-fir dwarf mistletoe infection. Photo interpreted and EMDS modelled data; however, were used to provide an estimate of the extent of Douglas-fir dwarf mistletoe vulnerability in the Buttermilk Creek and Libby Creek sub-watersheds following data validation with field observations of dwarf mistletoe infection and local knowledge of the project area. Douglas-fir bark beetle (DFB) vulnerability was used as a surrogate for estimating the extent of dwarf mistletoe vulnerability in the project area. Factors affecting Douglas-fir dwarf mistletoe infection dynamics are very similar to factors used by EMDS to model DFB vulnerability (including site quality, host abundance, canopy structure, stand density, and host patch connectivity). DFB vulnerability was adjusted by including dry forest areas located below 5,001 feet elevation with a high or moderate DFB hazard rating and moist forest areas below 5,001 feet elevation with a high DFB hazard rating to estimate the total area in each sub-watershed where forest vegetation is vulnerable to Douglas-fir dwarf mistletoe infection. The total acreage of treatment in the Libby Creek and Buttermilk Creek sub-watersheds to reduce vulnerability to Douglas-fir dwarf mistletoe infection and improve resilience to natural disturbances was used to measure the effects of alternatives.

Figure 47. Vegetation Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Forest Vegetation Composition and Structure.	The amount and arrangement of dry and moist forest structures compared to the desired range of variability.	Percentage of Buttermilk and Libby Creek landscapes occupied by dry forest and moist forest structures.	P&N #3	Restoration Strategy
		Average patch size (in acres) of dry forest and moist forest structures in the Buttermilk and Libby Creek landscapes.		
	Forest patches with large and medium size trees.	Acres treated in the Buttermilk and Libby Creek landscapes to maintain and restore large trees in patches with medium, large, or large and medium size trees.		
Resilience to biotic natural disturbances.	Western spruce budworm vulnerability compared to the desired range of variability.	Percentage of Buttermilk and Libby Creek landscapes with high, moderate, and low risk of Western spruce budworm infestation.	P&N #3	LRMP S&G 20-15, 20-35, MA5-19F Restoration Strategy Spruce Budworm Assessment
	Forest vegetation vulnerable Douglas-fir bark beetles.	Acres of treatment in the Buttermilk and Libby landscapes with high or moderate risk of Douglas-fir bark beetles.	P&N #3	LRMP S&G 20-15, 20-35, MA5-19F
	Forest vegetation vulnerable to dwarf mistletoe infection.	Acres treated in the Buttermilk and Libby Creek landscapes to reduce vulnerability to dwarf mistletoe infection.	P&N #3	LRMP S&G 20-15, 20-35, MA25-19F, MA5-19F

3.5.2 Intensity Level Definitions

The following definitions will be used to describe the types of impacts that would be caused by proposed actions analyzed in this report.

Type of Impact:

- Adverse: The percentage of the landscape (PL) or average patch size (APS) classes moves away from the desired range of variability. There is an increase in the amount of vulnerability to western spruce budworm, Douglas-fir bark beetle, and dwarf mistletoe infection.
- Beneficial: The percentage of the landscape (PL) or average patch size (APS) classes moves toward or stays within the desired range of variability. There is a decrease in the amount of vulnerability to western spruce budworm, Douglas-fir bark beetle, and dwarf mistletoe infection.

Duration of Impact:

- Short-term: Impact lasts up to 20 years.
- Long-term: Impact lasts more than 20 years.

Intensity of Impact:

- None: No impacts
- Negligible: Undetectable but measureable change to forest vegetation composition and structure or resilience to biotic natural disturbances in each sub-watershed; less than1% change in PL, less than 10% change in APS, or less 10% area treated for Douglas-fir bark beetle or dwarf mistletoe vulnerability.
- Minor: Slightly noticeable, localized effects to forest vegetation composition and structure or resilience to biotic natural disturbances between 1 and 25% PL or 11 and 25% APS in each sub-watershed.
- Moderate: Apparent change in plant community structure, composition, or fuels that shifts ecological functions over approximately 26-50% in each sub-watershed.
- Major: Substantial change in plant community structure, composition, and/or fuels that shifts ecological function across the majority of each sub-watershed.

3.5.3 Affected Environment

Resource Indicator: The amount and arrangement of dry and moist forest vegetation structures compared to the desired range of variability

Overview of dry and moist forest structures: Land management practices during most of the twentieth century, including wildfire suppression, timber harvest, and grazing, have contributed to changes in dry and moist forest structures and composition in the project area. These practices have altered the amount of dry and moist forest structures (successional stages) while reducing the abundance of large trees. Up until the 1990s, timber harvest focused on the selective removal of larger, fire tolerant trees over extensive areas and dispersed regeneration harvest treatments. Grazing practices prior to the 1970s are believed to have created favorable site conditions for the establishment of conifer regeneration. Fire suppression eliminated the historically dominant natural disturbance which reduced tree density and influenced structural development and species composition over the majority of the project area (Hessburg et al. 2015). These practices favored the development of dense and often multiple canopy layered structures (SECC, UR, and YFMS) which currently are more abundant in the project area compared to estimated historic levels in the dry forest type. Less dense, single canopy layer

structures (SEOC and OFSS) in the dry and moist forest types generally are less abundant compared to estimated historic levels. Dry and moist forest structures with a high proportion of large overstory trees currently are present at very low levels compared to estimated historic conditions (OFMS) or not present at all (OFSS). Dry forest vegetation in the project area has been altered to a greater extent than moist forest vegetation with regard to the amount of individual structure classes currently present

Past land management practices favored the establishment and growth of shade tolerant conifers, including Douglas-fir and subalpine fir. Selective harvest of larger overstory trees, particularly ponderosa pines, promoted regeneration and release of understory Douglas-firs. Fire suppression maintained conditions that are favorable for the development of shade tolerant trees and unfavorable for the establishment and growth of shade intolerant conifers including ponderosa pines. Over time, the proportion of Douglas-fir stocking in dry and moist forest structures in the project area has increased compared to ponderosa pine stocking. Subalpine fir has become more prominent than Douglas-fir in moist forest structures in portions of the project area. Douglas-fir and subalpine fir are less fire tolerant than ponderosa pine, and management practices have favored the development of less fire tolerant forest structures comprised of dense and multiple canopy layers (SECC, UR, and YFMS) with a high proportion of relatively smaller and less fire tolerant trees. Fire tolerant forest structures (SEOC and OFSS) have become less abundant in the project area.

The spatial arrangement of dry and moist forest structures in the project area has also been affected by past management practices. Selective harvest of larger trees over extensive areas, dispersed regeneration harvest treatments, and fire suppression have contributed to the fragmentation of forest structures in the project area. The average patch size of all dry and moist forest structure classes in the project area currently are at the low end of the range or smaller than the estimated historic average patch size range indicating that current patch sizes in general are smaller compared to historic conditions. Figure 48 displays current forest vegetation structures in the project area.

Restoration Strategy guidance implies that vegetation conditions including the amount and arrangement of dry and moist forest vegetation structures be maintained or restored to levels that are within ranges where the HRV and FRV overlap (the DRV) to provide for more sustainable and resilient forest ecosystems in the project area.

Buttermilk Creek: Dry forest structures occupy approximately 28% of the Buttermilk Creek landscape area. For Buttermilk Creek, the percentage of the landscape and average patch size of dry forest OFMS and OFSS structures are within the DRV for both measures; however, OFSS is at the minimum value for the desired ranges of variability (**Figure 49**). The average patch size of dry forest SI and UR structure classes are within the DRV and the average patch size of dry forest SECC and YFMS are above the DRV. The percentage of the landscape and average patch size of dry forest SEOC structures are below the DRV indicating that this structure class is underrepresented in relatively small patches on the landscape. Based on current dry forest conditions, the Buttermilk landscape evaluation determined there is a restoration need to reduce

the amount of area of dry forest SECC, SI, UR, and especially YFMS structures on the landscape and reduce the average patch size of dry forest SECC and YFMS structures.

Moist forest structures occupy approximately 8% of the Buttermilk Creek landscape area. For Buttermilk Creek, the percentage of the landscape and average patch size of moist forest OFMS and OFSS structures are within the DRV for both measures; however, they are present at levels which are at or near (OFSS and OFMS respectively) the minimum value for the desired range of variability (**Figure 49**). The percentage of the landscape of moist forest SECC, UR, and YFMS structure classes are within the DRV and the average patch size of moist forest SECC and YFMS structures are within the DRV. The average patch size of moist forest UR structures is below the DRV. The percentage of the landscape and average patch size of moist forest SEOC and SI structures are below the DRV indicating they are underrepresented in relatively small patches on the landscape. Based on current moist forest conditions, the Buttermilk landscape evaluation determined there is a restoration need to increase the amount of area and average patch size of moist forest SEOC, OFMS, and OFSS structure classes.

Libby Creek: Dry forest structures occupy approximately 46% of the Libby Creek landscape area. For Libby Creek, the percentage of the landscape and average patch size of dry forest OFMS and OFSS structures are within the DRV for both measures; however, they are present at levels which are at or near (OFSS and OFMS respectively) the minimum for the desired range of variability (**Figure 49**). The percentage of the landscape of dry forest UR structure is above the DRV and the amount of dry forest SECC and YFMS structure classes are well above the DRV which is strong indication that that dry forest SECC and YFMS structures are overabundant on the landscape. The average patch size of dry forest UR, SECC, and YFMS are within the DRV. The percentage of the landscape and average patch size of dry forest SI are within the DRV; however, the average patch size is near the minimum value for the desired range of variability. The percentage of the landscape for dry forest SEOC is within the DRV and the average patch size is below the DRV. Based on current dry forest conditions, the Libby Creek landscape evaluation determined there is a restoration need to reduce the amount of dry forest UR, SECC, and YFMS structures on the landscape and to consolidate dry forest SEOC and SI structures into larger patches, increasing the amount of SEOC and SI area on the landscape as needed.

Moist forest structures occupy approximately 11% of the Libby Creek landscape area. For Libby Creek, the percentage of the landscape and average patch size of moist forest OFMS and OFSS structures are within the DRV for both measures; however, they are present at levels which are at or near (OFSS and OFMS respectively) the minimum value for the desired range of variability (**Figure 49**). The percentage of the landscape of moist forest SECC, SI, UR, and YFMS structure classes are within the DRV. The average patch size for moist forest SECC and YFMS are within the DRV. The average patch size for most forest SI and UR are below the DRV. The percentage of the landscape and average patch size of moist forest SEOC structures are below the DRV indicating that moist forest SEOC is underrepresented in relatively small patches on the landscape. Based on current moist forest conditions, the Libby Creek landscape evaluation determined there is a restoration need to increase the amount of area and average patch size of

moist forest SEOC structures on the landscape while reducing the amount of YFMS area as needed.

Resource Indicator: Forest patches with large and medium size trees
Overview of forest patches with large and medium size trees: Large and medium size trees are important elements of forest vegetation composition. Large trees (greater than 25 inches DBH) commonly are old trees with an estimated age of 150 years and greater because of the time required to attain this size in the project area. As old forest or remnant trees, many large old trees, particularly ponderosa pines and Douglas-firs, historically were resistant to wildfires, survived periods of extended drought, provided seed and genetic resources spanning centuries of varying climatic conditions, and contributed important snag and cavity habitat after they died (Hessburg et al. 2015). Large trees play an important role in post-fire recovery processes including a seed source for regeneration provided by surviving trees and dead trees which provide a source of snags and down logs which ameliorate post-fire site conditions for vegetation reestablishment and add carbon to the soil. Larger medium size trees (21 to 25 inches DBH) are important because they commonly are the largest trees present in forest structures in the project area and are the best candidates for developing into large size trees in the future.

Historically, large trees were more common in the project area where they dominated the overstories of open and closed canopy, old forest structure patches and were present as remnant overstory trees in other structure classes across a larger portion of the project area (Hessburg et al. 2015). Land management practices during most of the twentieth century have reduced the abundance of OFMS and OFSS structures and remnant large trees distributed throughout the project area in other structure classes. Forest patches with large overstory trees and understory trees less than 16 inches DBH in the project area currently are within the DRV; however they are present at levels which trend toward the lower end of the desired range of variability in both landscapes. Past management practices have favored the development of dense and often multiple canopy layered structures in portions of the project area and this has affected existing large trees. Large trees are now typically competing for soil nutrients and water with higher levels of smaller and younger trees compared to historic conditions, which increases the risk of large tree mortality caused by bark beetle attacks. Increased stand density and inter-tree competition also reduces the likelihood of larger medium size trees from developing into large trees. Large trees and larger medium size trees currently are located in landscapes with higher levels of fire intolerant forest structures and are more likely to be growing in less fire tolerant patches compared to historic conditions which increases the likelihood of wildfires that could eliminate large trees and larger medium size trees. Other factors that affect the development and survival of large and medium trees are Douglas-fir dwarf mistletoe infestations and predation by western spruce budworm. **Figure 50** displays forest patches with large and medium size trees and old forest multistory structure patches currently present in the project area.

Buttermilk Creek: Forest patches with medium size overstory trees 16 to 25 inches DBH comprise an estimated 14,867 acres in the Buttermilk Creek landscape (63%; well above DRV of 24-28%). A majority of these patches are located in the Sawtooth Wilderness or are found in

the steeper, less accessible parts of the landscape. Forest patches with large overstory trees and understory trees smaller than 16 inches DBH comprise an estimated 2,391 acres in the Buttermilk Creek landscape (10%; within DRV of 5-29%). Forest patches with large overstory trees and medium size understory trees comprise an estimated 640 acres in the Buttermilk Creek landscape (3%; above DRV of 0-2%). Based on current conditions of forest patches with large and medium trees present, the Buttermilk Creek landscape evaluation determined there is a need to reduce the area of patches with medium size overstory trees and to maintain or increase the area of patches with large size trees (large overstory trees and understory trees less than 16 inches DBH).

Libby Creek: Forest patches with medium size overstory trees 16 to 25 inches DBH comprise an estimated 8,142 acres in the Libby Creek landscape (31%; within DRV of 24-58%). Forest patches with large overstory trees and understory trees smaller than 16 inches DBH comprise an estimated 321 acres in the Libby Creek landscape (1.2%; within DRV of 0.7-28%). Forest patches with large overstory trees and medium size understory trees currently are not present in the Libby Creek landscape (within DRV of 0-8%). Based on current conditions of forest patches with large and medium trees present, the Libby Creek landscape evaluation determined there is a need to increase the area in all structure classes with large trees, and thus a need to maintain existing large trees and restore large trees in patches with medium, large, or large and medium size trees.

Resource Indicator: Western spruce budworm vulnerability compared to the desired range of variability

Overview of western spruce budworm vulnerability: Natural disturbances including insect infestations influence forest vegetation successional patterns including structure and composition. Current insect patterns in the project area are the by-product of the effects of human action and altered disturbance regimes which are being driven by a warmer climate (Hessburg et al. 2015). Past management practices, including fire suppression and selective harvesting of larger trees, have favored the development of densely stocked and multiple canopy layered stand structures with a high proportion of Douglas-fir stocking in the overstory and understory canopy layers in portions the project area. Douglas-fir is the preferred host of the western spruce budworm in the project area and densely stocked forest patches with Douglas-fir trees in the upper and lower canopy layers are highly vulnerable to western spruce budworm defoliation (Carlson et al. 1985 and Hessburg et al. 1999). Repeated defoliation of host trees causes reduced tree growth, top kill, and mortality of trees. The majority of trees killed by defoliation are smaller understory trees; however, larger and typically older Douglas-fir trees are predisposed to fatal Douglas-fir bark beetle attacks by repeated defoliation. Restoration Strategy guidance implies that vegetation conditions including vulnerability to western spruce budworm infestation be maintained or restored to levels that are within ranges where the HRV and FRV overlap (the DRV) to provide for more sustainable and resilient forest ecosystems in the project area.

Figure 49 displays the percentage of the landscape with low, moderate, and high western spruce budworm vulnerability currently present in the project area.

Buttermilk Creek: Existing conditions in the Buttermilk landscape indicate the amount of area with low vulnerability to western spruce budworm infestation is below the DRV and underrepresented on the landscape (**Figure 49**). The amount of area with moderate vulnerability is within the DRV and present at a level that is close to the minimum value for the desired range of variability. The amount of area with high vulnerability is well above the DRV indicating that this vulnerability class is overabundant on the landscape. Based on current conditions, the Buttermilk landscape evaluation determined there is a restoration need to increase the amount of area with low western budworm vulnerability and to decrease the amount of area with high western budworm vulnerability on the landscape.

Libby Creek: Existing conditions in the Libby landscape indicate the percentage of the landscape with low vulnerability to western spruce budworm infestation is above the DRV and possibly overabundant on the landscape. The Libby Creek landscape; however has an unusually large portion of non-forested shrub land vegetation (approximately 20% of the landscape) which is classified low vulnerability and skews the estimate of the percentage of the landscape with low vulnerability. Current estimates of the percentage of the landscape with moderate and high western spruce vulnerability are within the DRV. There is a high degree of fragmentation of patches in all vulnerability classes with a high proportion of relatively small size patches distributed throughout the landscape. Many of these smaller patches, however are located in unroaded areas and areas which are low priority for treatment to maintain or restore dry and moist forest structures and/or fuel reduction. Based on current conditions, and restoration priorities, the project management team has determined that there is a need to maintain the percentage of the landscape with high vulnerability to western spruce budworm infestation within the lower half of the DRV.

Resource Indicator: Forest vegetation vulnerable Douglas-fir bark beetles
Douglas-fir bark beetle infestations are another form of natural disturbance which can affect forest vegetation successional patterns including structure and composition. Douglas-fir bark beetles are opportunistic and they typically attack low vigor Douglas-fir trees weakened by stress caused by disease, inter-tree competition, and drought, or by disturbances such as defoliation, fire injury, snow breakage, or blowdown. Factors affecting Douglas-fir beetle vulnerability include host abundance, number of canopy layers, stand density, host age and host patch connectivity, and as these values increase so does the risk rating. Medium and large size trees greater than 120 years old are more likely to be attacked. Past management practices have promoted the development of densely stocked and multiple canopy layered stand structures with high proportion of Douglas-fir stocking in the overstory and understory canopy layers in portions of the project area. These factors contribute to high risk of bark beetle attack primarily in relatively older medium and large size Douglas-fir trees in these areas.

In the Buttermilk Creek landscape, there are an estimated 6,061 acres with moderate vulnerability and 4,463 acres with high vulnerability to Douglas-fir bark beetle infestation. In the Libby Creek landscape there are an estimated 11,820 acres with moderate vulnerability and 2,532 acres with high vulnerability to Douglas-fir bark beetle infestation (**Figure 49**).

Resource Indicator: Forest vegetation vulnerable to dwarf mistletoe infection
Natural disturbances including tree diseases influence forest vegetation successional patterns including structure and composition. Dwarf mistletoe is a genus of parasitic plant that drastically affects growth patterns and health of Douglas-fir host trees as well as many other conifers. Douglas-fir dwarf mistletoe infects only Douglas-fir and it is the primary disease of concern in the project area. This species is native and has always been part of the eastern Washington landscape, but as a relatively minor component of forest patches (stands). Historically Douglas-fir dwarf mistletoe was widely distributed in the project area with little intensification. Dwarf mistletoe infections were confined to larger fire resistant trees located in patches, groups, or individual trees that were widely scattered throughout the project area or concentrated in riparian areas that rarely burned. Spread of the disease was limited by the influence of frequent low intensity fire that maintained more open stand structures with a high proportion of ponderosa pine and other non-host species (Hessburg and Mitchell 1994). Management practices during most of the twentieth century, including fire exclusion and selective harvesting, have favored the development of dense and often multiple canopy layered structures with a high proportion of Douglas-fir stocking in the overstory and understory canopy layers. Infection has intensified and spread from infected overstory trees into susceptible understory trees resulting in current infection levels that exceed historic levels of this disease.

There are approximately 6,349 acres within the Buttermilk Creek landscape and 10,941 acres within Libby Creek landscape that have been determined to be infected and/or vulnerable to Douglas-fir dwarf mistletoe infection. **Figure 51** displays the extent of forest vegetation vulnerable to dwarf mistletoe infection in the project area.

Figure 48. Existing vegetation structure for the project area.

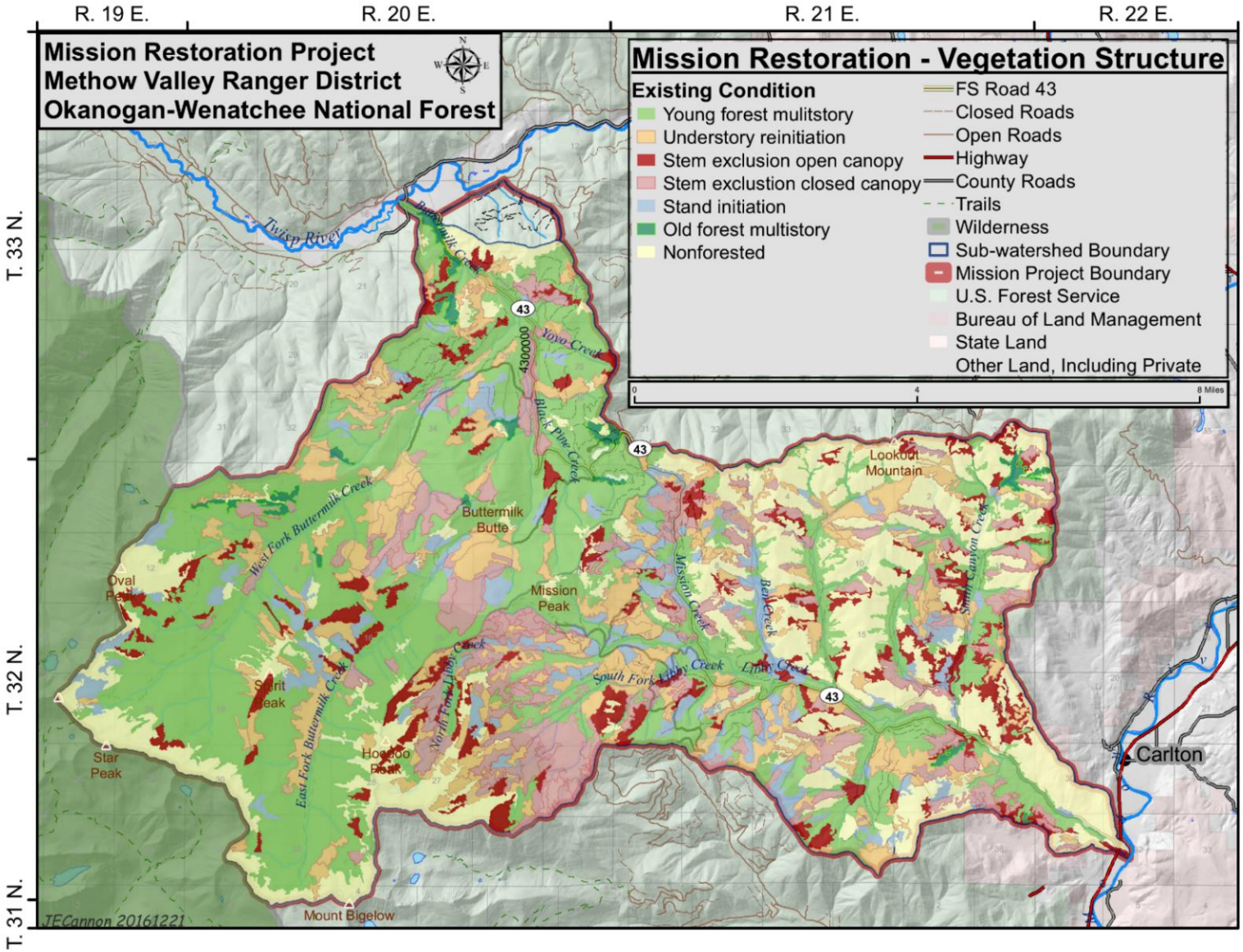


Figure 49. Vegetation Resource Elements, Indicators, and Measures

Resource Element	Resource Indicator	Measure	Existing Condition		
Restoration or maintenance of Forest Vegetation Composition and Structure.	The amount and arrangement of dry and moist forest structures compared to the desired range of variability.	Percentage of the Buttermilk and Libby Creek landscapes occupied by dry and moist forest structures.	**Dry Forest**		
			Structure	**Buttermilk**	**Libby**
			OFMS	1.4% Within DRV of 0-2.3%	0.04% Within DRV of 0-2.3%
			OFSS	0% Within DRV of 0-2.6%	0% Within DRV of 0-0.9%
			SECC	1.4% **Above** DRV of 0-0.3%	8.0% **Above** DRV of 0-0.8%
			SEOC	2.1% **Below** DRV of 3.5-6.6%	6.1% Within DRV of 3.5-17.4%
			SI	1.4% **Above** DRV of 0-0.5%	5.2% Within DRV of 0-10%
			UR	3.2% **Above** DRV of 0-2.3%	11.0% **Above** DRV of 0.2-9.9%
			YFMS	18.6% **Above** DRV of 0-1.7%	14.0% **Above** DRV of 0-9.1%
			Moist Forest		
			Structure	**Buttermilk**	**Libby**
			OFMS	0.5% Within DRV of 0-5.6%	0.5% Within DRV of 0-11.2%
			OFSS	0% Within DRV of 0-5.3%	0% Within DRV of 0-3.0%
			SECC	1.4% Within DRV of 0.4-5.6%	0.8% Within DRV of 0-5%
		.	**SEOC**	0.2% **Below** DRV of 2.5-12.3%	0.4% **Below** DRV of 2.5-12.3%
			SI	0.3% **Below** DRV of 0.9-8.9%	1.4% Within DRV of 0.9-9.9%
			UR	1.3% Within DRV of 1-10.3%	1.2% Within DRV of 1-18.4%
			YFMS	4.1% Within DRV of 0.7-8.4%	6.0% Within DRV of 0-18.1%
Restoration or maintenance of Forest Vegetation Composition and Structure.	The amount and arrangement of dry and moist forest structures compared to the desired	Average patch size of dry and moist forest structures in the Buttermilk and Libby landscapes Average patch size of dry and moist forest structures in the	**Dry Forest**		
			Structure	**Buttermilk**	**Libby**
			OFMS	68 ac. Within DRV of 0-340 ac	10 ac. Within DRV of 0-318 ac
			OFSS	0 ac. Within DRV of 0-168 ac	0 ac. Within DRV of 0-159 ac
			SECC	54 ac **Above** DRV of 0-36 ac	35 ac. Within DRV of 0-89 ac
			SEOC	29 ac **Below** DRV of 52-267	15 ac. **Below** DRV of 21-315 ac
			SI	29 ac. Within DRV of 0-90 ac	24 ac. Within DRV of 0-246 ac
			UR	47 ac. Within DRV of 0-137 ac	41 ac. Within DRV of 14-286 ac

Resource Element	Resource Indicator	Measure	Existing Condition		
	range of variability.	Buttermilk and Libby landscapes. (acres)	**YFMS**	200 ac. **Above** DRV of 0-183 ac	58 ac. Within DRV of 0-290 ac
			Moist Forest		
			Structure	**Buttermilk**	**Libby**
			OFMS	57 ac. Within DRV of 0-312 ac	27 ac. Within DRV of 0-348 ac
			OFSS	0 ac. Within DRV of 0-255 ac	0 ac. Within DRV of 0-213 ac
			SECC	68 ac. Within DRV of 42-927 ac	26 ac. Within DRV of 0-174 ac
			SEOC	37 ac. **Below** DRV of 50-249 ac	21 ac. **Below** DRV of 50-249 ac
			SI	31 ac. **Below** DRV of 32-177 ac	27 ac. **Below** DRV of 32-177 ac
			UR	39 ac. **Below** DRV of 68-246 ac	19 ac. **Below** DRV of 68-383 ac
			YFMS	74 ac. Within DRV of 46-363 ac	82 ac. Within DRV of 0-440 ac
	Forest patches with large and medium size trees.	Acres treated in the Buttermilk and Libby landscapes to maintain and restore large trees in patches with medium, large, or large and medium size trees.	**Buttermilk**		**Libby**
			Medium Trees – 14,867 ac available Large Trees - 2,391 ac available Large and Medium – 640 ac available		Medium Trees – 8,142 acres available Large Trees – 321 acres available Large and Medium – 0 acres available
Resilience to biotic natural disturbances.	Western spruce budworm vulnerability compared to the desired range of variability.	Percentage of the Buttermilk and Libby Creek landscapes with high, moderate, and low risk.			
			Risk	**Buttermilk**	**Libby**
			Low	15% **Below** DRV of 22-28%	32% **Above** DRV of 12-28%
			Moderate	15% Within DRV of 13-33%	11% Within DRV of 8-27%
			High	69% **Above** DRV of 31-52%	57% Within DRV of 29-74% But not within lower half of DRV

Resource Element	Resource Indicator	Measure	Existing Condition	
	Forest vegetation vulnerable to Douglas-fir bark beetles.	Acres of treatment in the Buttermilk and Libby landscapes with high or moderate risk.	Moderate - 6,061 acres available High - 4,463 acres available	Moderate - 11,820 acres available High - 2,532 acres available
	Forest vegetation vulnerable to dwarf mistletoe infection.	Acres treated in the Buttermilk and Libby Creek landscapes to reduce vulnerability.	Buttermilk = 6,349 ac. Available	Libby = 10,961 ac. Available

Figure 50. Large and medium sized trees in project area with proposed actions displayed.

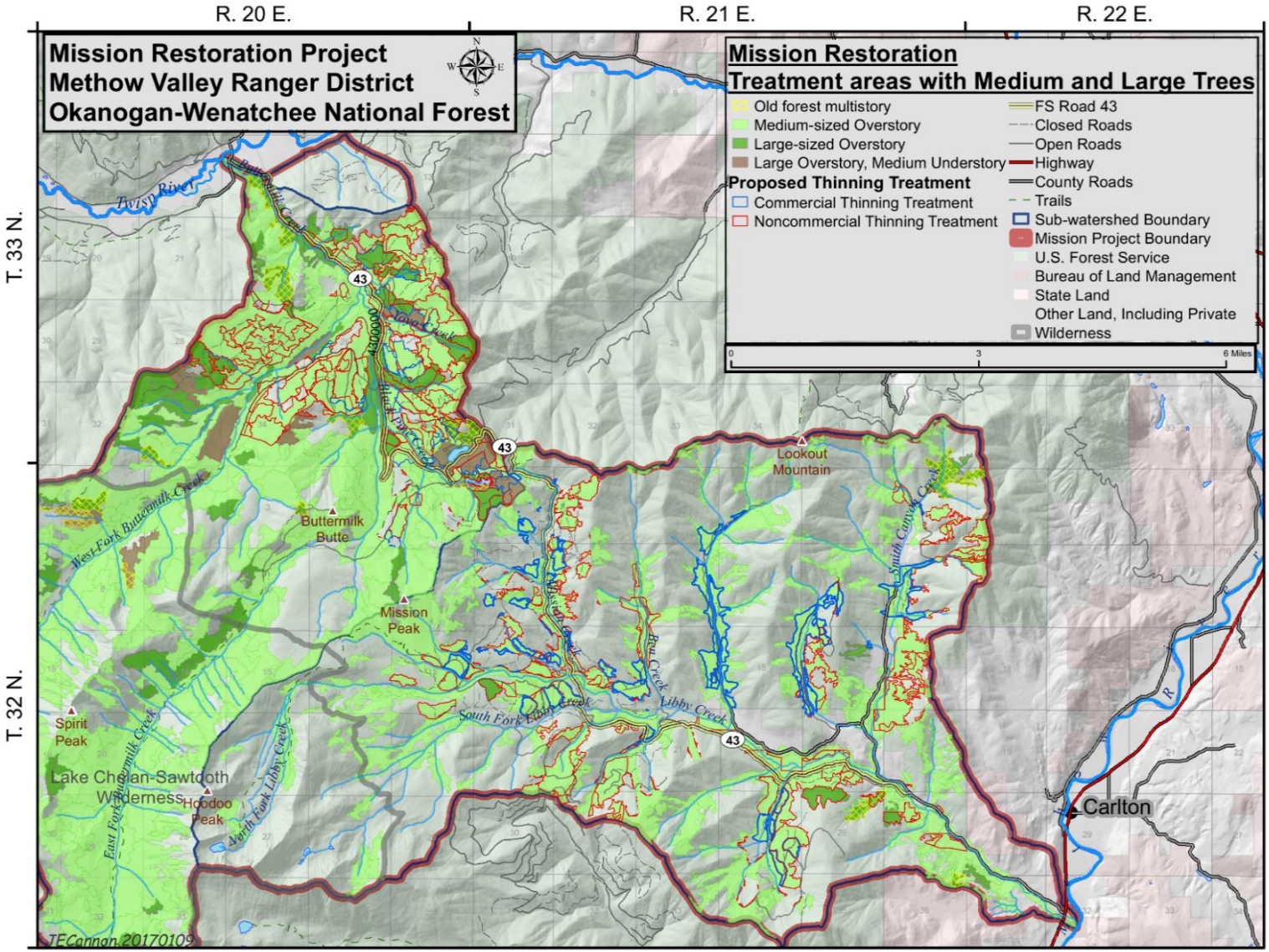
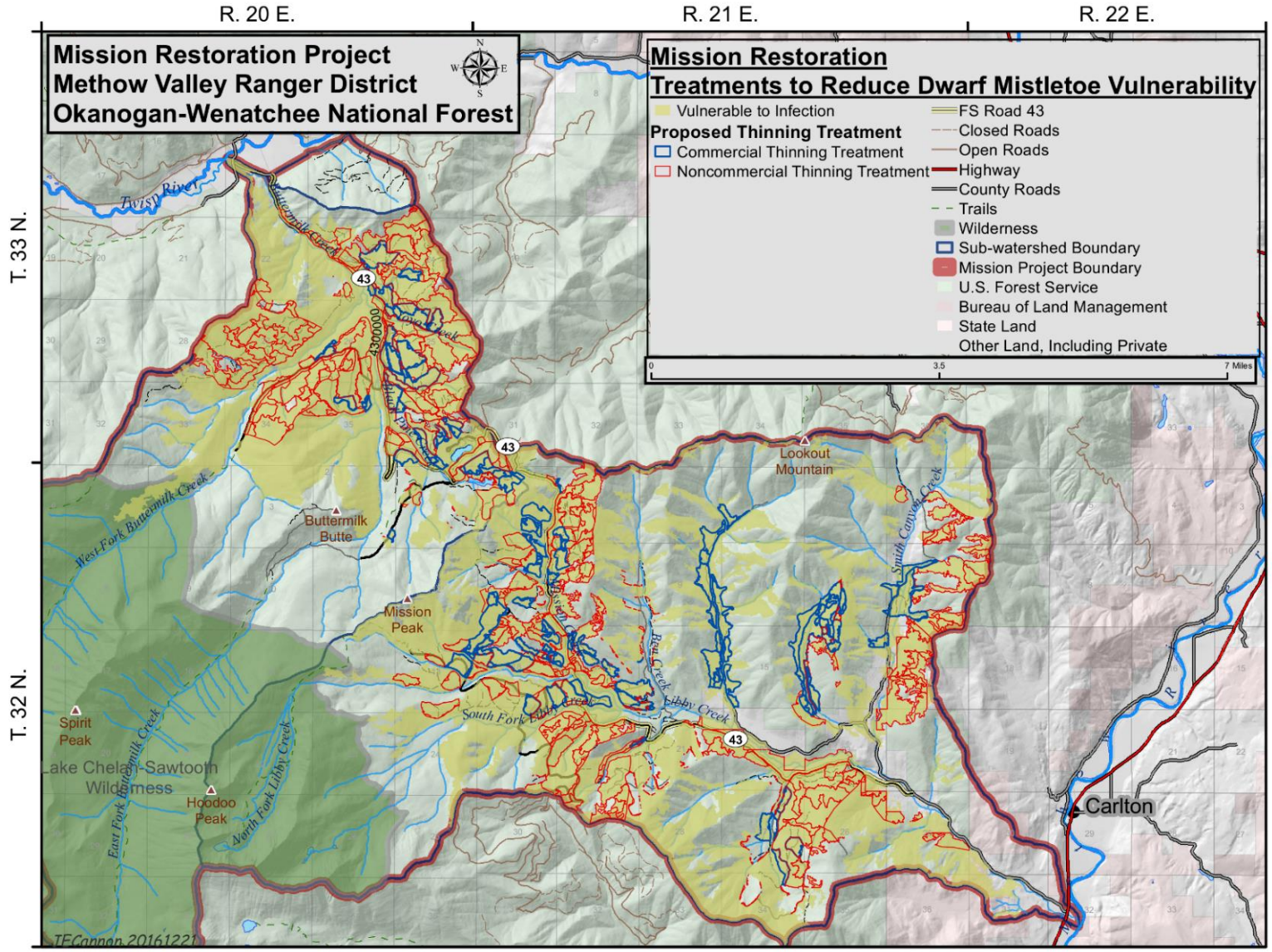


Figure 51. Area vulnerable to dwarf mistletoe with proposed actions displayed.



Note to reader: Page references provided in the Notice of Opportunity to Comment for the Mission Revised Preliminary EA may be off by one number in this excerpt from the full document.

3.5.4 Environmental Consequences

3.5.4.1 Considered, but not Analyzed in Detail

The following proposed actions will not be considered further in this analysis because they would have no measurable effect on the restoration or maintenance of the amount and arrangement of dry and moist forest structures, forest patches with large and medium size trees, western spruce budworm vulnerability, forest vegetation vulnerability to Douglas-fir bark beetles, or forest vegetation vulnerability to dwarf mistletoe infection in the Buttermilk and Libby Creek landscapes: fuels reduction treatments in the Buttermilk Annex area, soil restoration, rock armoring, replacing undersized culverts or installing fish culverts, beaver habitat enhancement, coarse woody debris enhancement, or creating hardened fords.

3.5.4.2 Alternative 1

3.5.4.2.1 Effects

Resource Indicator: The amount and arrangement of dry and moist forest vegetation structures compared to the desired range of variability

Under Alternative 1, there would be no immediate change in either dry or moist forest vegetation structures in either of the analyzed landscapes. The Percent Landscape (PL) and Average Patch Size (APS) departures for forest structure in moist and dry forest types identified in the Affected Environment section would persist until either new disturbance (fire, defoliation or windthrow) or tree growth put patches in new structure categories. Within the next 20 years (short term), without any man caused or natural disturbances, understory canopies would continue to develop and the percent landscape and perhaps the average patch size of the single storied and/or open stand structures (SI, SEOC and OFSS) would be reduced fairly dramatically (minor), such that where these are currently within DRV, they would likely drop below DRV and if they are currently below HRV, they would stay there until a disturbance takes place (long term). These structure types would evolve to more complex structure types (UR, YFMS and OFMS) such that that if these types are currently below the Desired Range of Variability (DRV), they could go toward or land within DRV within the next 20 years, while if they are currently over DRV they would likely continue to be above until a disturbance takes place. SEEC patches, which tend to grow fairly slowly because of tree to tree competition are likely to stay as they are for at least the next 20 years or until the next disturbance.

Resource Indicator: Forest patches with large and medium size trees

Under the no action alternative there would be no overstory and understory treatments. There would be no reduction of inter-tree competition, no reduction in vulnerability to bark beetles, western spruce budworm, or Douglas-fir dwarf mistletoe; and no increase of resiliency to fire; all of which would benefit large and medium sized trees. There would be no immediate change in the area of patches with medium and large tree components. However, under drought conditions and especially in conjunction with insect defoliation, dwarf mistletoe or root disease infection, it is very common for the largest trees in a densely stocked stand to succumb to bark beetles. Multiple tree canopy layers and buildup of surface and ladder fuels can contribute to undesired large and medium size tree mortality in the event of wildfire. If enough large and

medium sized trees die, then stands that currently are regarded as stands that contain medium and large trees could lose this attribute. Without thinning younger stands, it would take longer, up to twice as long, for individual trees within these young stands to promote into medium and large size classes. This adverse effect would last until these patches are actively managed, which based on the average length of time to return to a planning area, could be up to 20 years (short term) and it is likely for the Percent Landscape with medium and/or large trees to be reduced by one percent during that time frame with possibilities of much higher impact.

Resource Indicator: Western spruce budworm vulnerability compared to the desired range of variability

Under Alternative 1, there would be no immediate change in western spruce budworm vulnerability levels in both landscapes within the project area. In the short term, vulnerability levels would remain relatively static for approximately 20 years.

In the Buttermilk landscape, the percentage of the landscape (PL) with low risk of defoliation would remain below the DRV, the PL with moderate risk would remain within the DRV, and the PL with high risk would continue to remain well above the DRV. The adverse effects to Low and High categories would last until these patches are actively managed. Overall, these conditions would contribute to an adverse, short term, negligible effect on western spruce budworm vulnerability in the Buttermilk Creek landscape.

In the Libby Creek landscape, the percentage of the landscape (PL) with low risk of defoliation would remain above the DRV for the next 20 years; however, as described previously in the Affected Environment description, this measure is skewed by the unusually high amount of non-forested shrub-land vegetation present in the landscape. The PL with moderate risk would remain within DRV and high risk of defoliation would remain above the lower half of DRV. The effects, for the next 20 years would be adverse, short-term and negligible.

Over the long term, western spruce budworm vulnerability would change in the project area with no action. Factors affecting vulnerability to defoliation include host abundance, number of canopy layers, stand density, and host patch connectivity, and as these values increase so does the risk of defoliation. Douglas-fir stocking levels in the project area would be expected to increase in all canopy layers primarily in the dry and moist forest vegetation types. Forest structures with multiple canopy layers and a high proportion of Douglas-fir stocking in all layers would increase as would the total area with high risk of defoliation. This increase in high risk would come from areas currently rated as moderate risk for defoliation. The total area with low risk of defoliation would decrease as some areas currently with low risk rating change to moderate risk. The total area with moderate risk would change based on the net effect of recruitment from current low risk patches and the loss of moderate risk patches which develop into high risk.

Resource Indicator: Forest vegetation vulnerable Douglas-fir bark beetles

Under Alternative 1, there would be no reduction of forest vegetation vulnerability to Douglas-fir bark beetle (DFBB) attacks on the 17,881 acres with moderate risk and the 6,985 acres with high risk in the project area. Forest vegetation conditions affecting DFBB vulnerability including host abundance, number of canopy layers, stand density, host age, and host patch connectivity would persist or increase over time in the project area. The amount of area with high risk would increase as Douglas-fir stocking levels and multiple canopy layer structures increase in areas

which currently are rated as moderate risk. Low vigor medium and large trees in high and moderate risk areas would remain vulnerable to fatal bark beetle attacks. As Douglas-firs which regenerated or were released from competition by selective harvesting during the past century mature and become older than 120 years, the amount of susceptible trees would increase, further contributing to Douglas-fir bark beetle vulnerability in the project area. The effects of no action would last until the next opportunity to manage, which may be up to 20 years. Overall, these conditions would contribute to an adverse, short-term, minor effect on the reduction of DFBB vulnerability in the Buttermilk Creek and Libby Creek landscapes. However, with such a high proportion of the area in High vulnerability to DFBB, should an epidemic of Douglas-fir bark beetle take place within the project area, there would likely be an increased wildfire risk until the epidemic wanes and the levels of resulting red and fine fuels have subsided. If a wildfire should take place during this extremely vulnerable condition, it could have adverse, long term, major effects on medium and large Douglas-fir trees. The current potential for DFBB epidemic is fairly high due to recent defoliation and drought.

Resource Indicator: Forest vegetation vulnerable to dwarf mistletoe infection
Under Alternative 1, there would be no reduction of dwarf mistletoe vulnerability on the 17,310 acres of forest vegetation vulnerable to infection within the project area.

Douglas-fir dwarf mistletoe (DFDM) vulnerability factors are presence of DFDM in or near a stand, presence of the host species (Douglas-fir), high proportions of the host species, and multiple canopy layers of the host species (Hessburg et al. 1999). There would be no reduction of any of these factors under Alternative 1. It is not likely that the acres of stands vulnerable to DFDM would increase more than one percent. Therefore, the effects of no treatment on the acres of the project area vulnerable to DFDM would be adverse, short-term and negligible. However, the effect of no treatment would result in a deterioration of tree and patch health that would be adverse, long-term and moderate.

Within stands that are currently infected with DFDM, within tree infection levels would increase and tree to tree infection would continue, especially in stands with multiple canopies of Douglas-fir which facilitates seed dispersal. Seeds are ejected to up to 50 feet from fruiting DFDM plants. DFDM would spread more slowly through stands that have a low proportion of Douglas-fir or are single storied stands. An average rate of DFDM movement through a stand is 1-2 feet per year (Washington State University Forestry Extension). Any intensification of disease within a tree or a patch is irreversible and long term without active management.

In the many stands that have low intensities of infection, there would be little effect to the ability of the stands to achieve large diameter tree status. Severe levels (number of trees infected) and intensities (proportion of the tree infected) of dwarf mistletoe can change the trajectory and potential of stand development. The average diameter growth rate is reduced by half with severe infections (Hawksworth and Wiens 1996). Poor diameter growth in Douglas-fir trees results in higher risk to bark beetle attack and exacerbates the effects of root disease in drought conditions (P. Nash, USFS, personal communication). This early mortality reduces the length of time that mature and complex stand structures are on site. Dwarf mistletoe infection in younger stands is likely to reduce the potential for these stands to attain desired structure classes (Geils and Mathiasen 1990).

Heavy masses of foliage and small branches (brooms) that are caused by the parasitic plants increase bulk crown density and are likely to hang low to the ground or break off and lay at the base of the tree, forming ladder and ground fuels. These brooms are especially flammable due to the dead material that accumulates within, the abundance of fine branches and the concentration of resins. Stands with severe levels and intensity of dwarf mistletoe are at higher risk to crown fires than similar, uninfected stands (Schmitt 2000).

3.5.4.3 Alternatives 2 and 3

Proposed overstory thinning and noncommercial thinning vegetation treatments to affect the amount and arrangement of dry and moist forest structures, forest patches with large and medium size trees, and western spruce budworm vulnerability, forest vegetation vulnerable to Douglas-fir bark beetles, or forest vegetation vulnerable to dwarf mistletoe infection in the Buttermilk and Libby Creek landscapes are identical in Alternatives 2 and 3. The effects for both of these alternatives will be described in this section.

3.5.4.3.1 Effects

Resource indicator: The amount and arrangement of dry and moist forest vegetation structures compared to the desired range of variability

Under Alternatives 2 and 3, a combination of overstory and understory treatment would result in changing or maintaining stand structure in many of the stands treated. For the most part, only overstory treatment combined with understory fuel treatments would have the potential of changing forest structure, while standalone fuels treatments are only seen to contribute towards maintenance of existing structures or contribute over the long term towards promotion of structures with larger diameter trees. Structure conversion treatments that would depend on the reduction of understory trees would have a duration of up to 20 years (short-term), at which point understory would have regenerated to the point that it would return to a multiple storied forest structure. Treatments that would result in conversion from SECC to other structures or the creation of SI (Variable Retention Regeneration harvest and post-harvest planting) would last 20-40 years (long-term) until tree growth moved the stands towards other forest structure types. The effects are shown for each structure type in **Figure 52** and a map of post-project vegetation structure is displayed in **Figure 53**. The planned treatments of overstory together with understory treatments would have a long-term effect and the stand-alone understory treatments would have a short term effect of promoting stands with medium and medium and large sized trees towards Old Forest characteristics.

Buttermilk Creek: Within the Buttermilk Creek Landscape, the planned treatments (655 acres of overstory treatments together with understory treatments as well as 3,138 acres of standalone fuels treatments) would result in creating 120 and 10 acres of SEOC stands within Dry and Moist forest by thinning SECC. 62 acres of SEOC would be created from thinning UR stands in Dry Forest. Thinning YFMS in Dry and Moist forest would result in 313 and 6 acres respectively. Within the Dry Forest, pre-commercial thinning would result in moving 34 acres of SI to SEOC and 46 acres of SI to YFMS. An equal amount of SI is expected to be created in response to fuels treatments that expose mineral soil in currently unforested areas. The remaining 122 acres of overstory treatment would contribute towards maintenance of existing SEOC and OFMS. The effects of Alternatives 2 and 3 to stand structure and average patch size are displayed in **Figure 52**.

Overall, combining the effects of 3,819 acres of planned treatment, which is 16 percent of the Buttermilk landscape, the effects would be beneficial and short-term with minor intensity on the Amount and Arrangement of Dry and Moist Forest Structures Size for the various structure types within the Buttermilk landscape.

Libby Creek: Within the Libby Creek Landscape, the planned treatments (1,363 acres of overstory treatments together with understory treatments as well as 4,215 acres of standalone fuels treatments) would result in creating 1,077 acres of SEOC patches within Dry by thinning 165 acres of SECC, 259 acres of UR and 627 acres of YFMS and 75 acres of SI from YFMS within in Dry Forest. Treatments in Moist Forest would result in moving 126 acres of YFMS to SEOC structure. Thinning would result in moving 79 acres of Dry Forest YFMS to in order to consolidate existing SI patches, increase patch size, and reduce fragmentation of Dry forest SI patches in the landscape. The remaining 111 acres of overstory treatment contributed towards maintaining Northern Spotted Owl Habitat (22 acres) and maintenance of existing SEOC. 487 and 180 acres of SI in Dry and Moist Forest, respectively, would be treated through standalone understory treatment to promote future SEOC. Approximately 25 acres of moist OFMS would be maintained through understory fuels reduction.

Overall, combining the effects of 4,594 acres of planned treatment, which is 18 percent of the Libby landscape, the effects would be beneficial and short-term with minor intensity on the Amount and Arrangement of Dry and Moist Forest Structures Size for the various structure types within the Buttermilk landscape.

Resource Indicator: *Forest patches with large and medium size trees*
Under both Alternatives 2 and 3, approximately 3,306 acres (575 acres of overstory treatment) out of the 17,898 acres with large or medium trees would be treated in the Buttermilk Creek landscape and another 3,080 acres (889 acres of overstory treatment) out of the 8,463 acres with large and medium trees would be treated in the Libby Creek landscape. These treatments would reduce tree stress from inter-tree competition; decrease vulnerability to defoliators and dwarf mistletoe; and increase fire resiliency within treated stands. This would result in the increased potential for survival of large and residual medium trees within the treated acres as well as increase the growth rate of remaining trees that could eventually result in promoting trees into larger size classes and stands into Old Forest Structure characteristics (see **Figure 52**). Overstory treatments, together with understory treatments are the most effective and enduring because stocking levels of overstory trees would be reduced and more dwarf mistletoe infected trees would be removed, which decreases dwarf mistletoe infection rates of the remaining trees. The increased growth and corresponding increased health due to overstory/understory treatments would have beneficial, long-term, minor effects in both Buttermilk and Libby landscapes. The effectiveness of stand-alone fuels treatments would have shorter duration and would result in beneficial, short-term, minor effects for both landscapes.

No large trees would be harvested. Some of the medium sized trees would be harvested during overstory thinning and sanitizing, but on the most part, the vast majority of these trees were identified to be retained. It is possible that heavily diseased patches (VRR and DFDMT treatments) or patches with barely enough medium trees to qualify for this patch attribute, may not qualify as patches with medium sized trees after harvest treatments, but the resulting percent of the landscape with medium sized trees would continue to be above DRV for Buttermilk and within DRV for Libby landscapes.

Although there appears to be a need and opportunity to reduce the overabundance of stands with Medium sized trees within the Buttermilk landscape, the actual options to do this in the short term are somewhat limited. The only logical way to do this would be to move UR or YFMS structure to SI structure and SI is already above DRV in the dry forest. The amount of SI in moist forest is on the low end of the DRV, but most of the moist forest patches with Medium sized trees are in the Sawtooth Wilderness and many more potential treatment patches are in areas with no or limited road access. The result is that no patches would be intentionally moved from "Medium" sized trees to "Small" sized trees. However, over time, many of the treated patches would promote into "Large" or "Medium and Large" tree categories.

The expected affects to untreated patches with Medium sized trees would be the same as shown for the No Action alternative.

Resource Indicator: Western spruce budworm vulnerability compared to the desired range of variability

Under Alternatives 2 and 3 a combination of overstory and understory thinning treatments would result in changes and maintenance of western spruce budworm vulnerability risk ratings in the project area. For the most part, overstory thinning treatments combined with understory fuels reduction treatments would have the greatest potential to change vulnerability risk ratings, whereas standalone understory thinning treatments would be more likely to maintain existing vulnerability risk ratings. Overstory thinning treatments would reduce western spruce budworm vulnerability by reducing the density of susceptible host trees 7 to 9 inches DBH and larger in the overstory and understory canopy layers, increase the proportion of residual tree stocking with non-host species including ponderosa pine, and effectively reduce the number of canopy layers in treated areas. The Variable Retention Regeneration treatments would reduce host composition and replace it with ponderosa pine seedlings. Understory thinning treatments would reduce vulnerability of defoliation only in the understory canopy layer by reducing the density of susceptible host trees 8 inches DBH and smaller and would reduce the number of canopy layers where the majority of understory trees are in this size range. Residual Douglas-firs in treated areas would benefit from reduced levels of inter-tree competition for sunlight, water, and soil nutrients which would improve their vigor and ability to withstand and recover from western spruce budworm defoliation should it occur. Treatment effects on vulnerability ratings would be expected to last for approximately 30 years at which time sufficient levels of vulnerable understory trees would become established to diminish treatment effectiveness. Details of post-treatment western spruce budworm vulnerability risk ratings are provided in **Figure 52**.

Buttermilk Creek: In the Buttermilk Creek Landscape, 655 acres of overstory thinning treatments followed by understory thinning treatments and 3,138 acres of standalone understory thinning treatments would be applied. Following treatment the Percentage of the Landscape (PL) with low risk of defoliation would increase by 1% and move toward attainment of the DRV. The PL for moderate risk would increase by 4% and remain within the DRV. The PL for high risk would decrease by 4% and move toward attainment of the DRV. Overall, post-treatment conditions would be a combination of beneficial, long term, minor effects on western spruce budworm vulnerability classes.

Libby Creek: In the Libby Creek Landscape, 1,363 acres of overstory thinning treatments followed by understory thinning treatments and 4,215 acres of standalone understory thinning treatments would be applied. Following treatment the Percentage of the Landscape (PL) with

low risk of defoliation would increase by 1% and move away from attainment of the DRV. The PL for moderate risk would increase by 6% and remain within the DRV. The PL for high risk would decrease by 7% and move toward attainment of the DRV. Overall, post-treatment conditions would be a combination of beneficial, long term, minor effects for the moderate and high vulnerability classes and an adverse, long term, negligible effect for the low western spruce budworm vulnerability class. Although increasing low vulnerability when it is already above DRV may be adverse for landscape vegetation patterns, it would benefit the health of medium and large Douglas-fir trees and all of the other vegetation attributes that depend on that species and size of trees.

Resource Indicator: Forest vegetation vulnerable Douglas-fir bark beetles
Under Alternatives 2 and 3, there would be overstory and understory treatments totaling 137 acres within patches with Moderate and 513 acres of treatment with High vulnerability to Douglas-fir bark beetles (DFBB) within the Buttermilk landscape, representing 6% of the moderate and high vulnerability acres. Within the Libby landscape there would be overstory and understory treatments totaling 971 acres within patches with moderate vulnerability and 404 acres of treatment with high vulnerability to DFBB, which would be 10 percent of the treated. These treatments would be effective in reducing host abundance, number of canopy layers, stand density in the treated stands. By reducing all of these factors in vulnerability to DFBB, individual tree vigor should improve, allowing these trees to produce pitch and defend themselves from beetle attacks. The thinning of the overstory and the reduction in the abundance of Douglas-fir would be effective for the next 20-40 years, while the understory would return within 20 years. This would result in beneficial, long-term, negligible effects for both landscapes. The Variable Retention Regeneration with planting ponderosa pine after harvest treatments would decrease host species and increase non-host specie composition on 80 acres. This effect would last indefinitely. Also, by simultaneously reducing risk for Western spruce budworm and crown fire there is a synergistic effect of reducing the potential for a disturbance that could trigger DFBB outbreaks.

Simultaneously with these more complete treatments, the vulnerability to DFBB would be moderated by understory treatments in an additional 2,845 acres of moderate and high Vulnerability patches in the Buttermilk landscape. Within the Libby landscape, 2,477 acres of the Moderate and High vulnerability patches would receive understory treatments. The duration of these treatments would be more ephemeral than that of overstory treatments and some of the vulnerability factors would only partially be treated. These treatments, which represent 27% and 24% of the moderate and high vulnerability patches in the Buttermilk and Libby landscapes respectively. These treatments alone would provide beneficial, short-term, minor impacts for both landscapes, but together with overstory treatments, would result in beneficial, short-term, moderate effects for both landscapes. Also, by simultaneously reducing risk for Western spruce budworm and crown fire, there is a synergistic effect of reducing the potential for a disturbance that could trigger DFBB outbreaks.

Resource Indicator: Forest vegetation vulnerable to dwarf mistletoe infection
Under Alternatives 2 and 3, 633 of the 6,349 acres of stands identified as vulnerable to Douglas-fir dwarf mistletoe infection within the Buttermilk landscape and 1,305 of 10,961 acres of vulnerable stands within the Libby Creek landscape would receive both overstory and understory treatments. Overstory, together with follow-up ladder fuel reduction treatments,

would remove most DMT infected trees less than 18 inches DBH from those patches. Some DMT infected trees between 18 and 24 inches DBH may also be harvested but the need to do this would be weighed against their contribution to elements of Old Forest structure. Overstory treatments would reduce the density of susceptible host trees and the number of canopy layers, increase the proportion of residual tree stocking with non-host species including ponderosa pine, and isolate residual infected trees in groups or individual trees to reduce vulnerability to infection in the treated stands. The planned Variable Retention Regeneration harvest treatment areas would be planted in ponderosa pine, post-harvest. This would result in reducing host specie and increasing no-host specie composition. These treatments would also restore elements of historic tree species composition and dwarf mistletoe distribution in treated areas. These treatments would have beneficial, long-term, negligible impact in the Buttermilk landscape and beneficial, long-term minor impact on the Libby landscape.

The 2,718 and 3,190 acres of standalone non-harvest thinning treatments planned for the Buttermilk and Libby landscapes, respectively, would result in removal of susceptible understory host trees and a reduction of DFDM in the remaining smaller trees. These treatments would also reduce the number of canopy layers in the treated stands. Where there are no infections in the overstory, these stands would have the potential to progress to target stand structures. These treatments would have beneficial, short term, minor impact to both of the landscapes.

In currently infected stands, the effects of stand thinning, as well as the removal of DFDM infected trees should result in a reduction of competition for remaining trees resulting in increased vigor, overall increase of average diameter growth within treated stands, and an increased potential to survive fires. This would result in increased potential and rate for treated stands to attain or retain desired structure classes. The effects of this treatment should result in a 20-40 year improvement in DFDM rating for the totally sanitized stands.

Infection intensity of any DFDM infected trees that remain would increase by responding to increased sunlight reaching infected branches and by having unimpeded dispersal (Graham 1961). Where infected trees remain in the overstory, future sanitizing and thinning treatments of understory trees would be needed or DFDM would spread to this new cohort of host species and stand DFDM ratings and landscape vulnerability to DFDM would return to current levels.

In stands that are currently free of DFDM, overstory treatment would result in decreased vulnerability by reducing the density of Douglas-fir trees, reducing the overall stocking and reducing number of tree canopies. Reduced vulnerability to DFDM would maintain the potential for those stands to continue to develop towards meeting resource objectives.

Overall, the vegetation treatments in Alternatives 2 and 3 would result in a beneficial, short term, minor effect on the Buttermilk landscape and a beneficial, long-term, minor effect on the Libby landscape.

Figure 52. Vegetation Resource Indicators and Measures Common to Alternatives 2 and 3

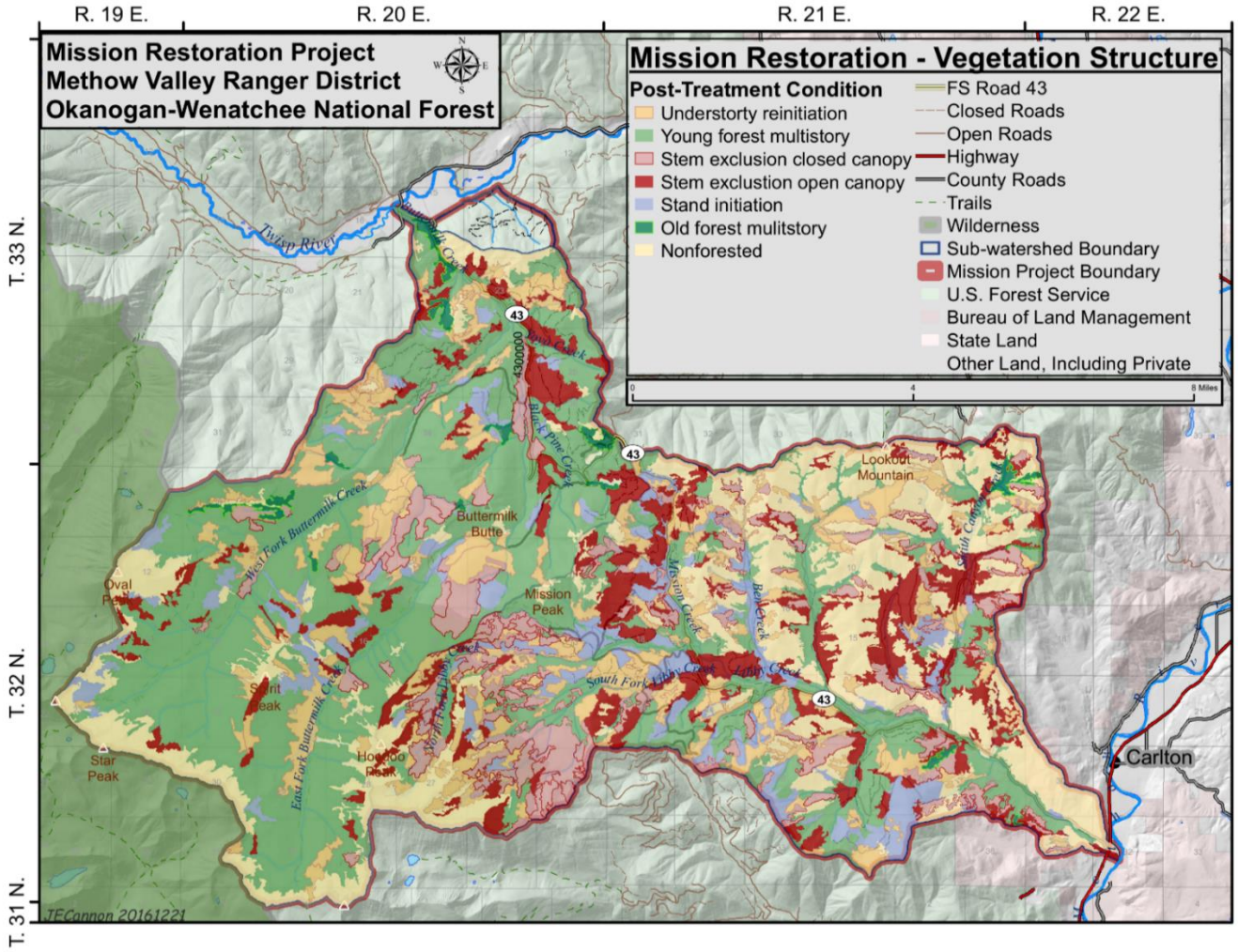
Resource Element	Resource Indicator	Measure	Effects of Alternatives 2 and 3		
Forest Vegetation Composition and Structure.	The amount and arrangement of dry and moist forest structures compared to the desired range of variability.	Percentage of the Buttermilk and Libby Creek landscapes occupied by dry and moist forest structures.	**Dry Forest**		
			Structure	**Buttermilk**	**Libby**
			OFMS	1.4%; No Immediate Change Remains Within DRV of 0-2.3%	0.4%; No Immediate Change Remains Within DRV of 0-2.3%
			OFSS	0%; No Immediate Change Remains Within DRV of 0-2.6%	0%; No Immediate Change Remains Within DRV of 0-0.9%
			SECC	0.6%; Decrease: 0.8% Remains **Above** DRV of 0-0.3%	6.5%; Decrease: 1.5% Remains **Above** DRV of 0-0.8%
			SEOC	4.5%; Increase: 2.4% Now within DRV of 3.5-6.6%	11.9%; Increase: 5.8% Remains Within DRV of 3.5-17.4%
			SI	1.3%; Decrease: 0.1% Remains **Above** DRV of 0-0.5%	6.4%; Increase: 1.2% Remains Within DRV of 0-10%
			UR	3.3%; Increase: 0.1% Further **Above** DRV of 0-2.3%	10.2%; Decrease: 0.8% Remains **Above** DRV of 0.2-9.9%
			YFMS	17.1%; Decrease: 1.5% Remains **Above** DRV of 0-1.7%	11.0%; Decrease: 3.0% Remains **Above** DRV of 0-9.1%
			Moist Forest		
			Structure	**Buttermilk**	**Libby**
			OFMS	0.5%; No Immediate Change Remains Within DRV of 0-5.6%	0.5%; No Immediate Change Remains Within DRV of 0-11.2%
		.	**OFSS**	0%; No Immediate Change Remains Within DRV of 0-5.3%	0%; No Immediate Change Remains Within DRV of 0-3.0%
			SECC	1.4%; Negligible Change Remains Within DRV of 0.4-5.6%	0.8%; No Change Remains Within DRV of 0-5%

Resource Element	Resource Indicator	Measure	Effects of Alternatives 2 and 3		
			SEOC	0.4%; Increase: 0.2% Remains **Below** DRV of 2.5-12.3%	0.7%; Increase: 0.3% Remains **Below** DRV of 2.5-12.3%
			SI	0.3%; No Change Remains **Below** DRV of 0.9-8.9%	1.3%; Decrease: 0.1% Remains Within DRV of 0.9-9.9%
			UR	1.3%; Negligible Change Remains Within DRV of 1-10.3%	1.1%; Decrease: 0.1% Remains Within DRV of 1-18.4%
			YFMS	3.9%; Decrease: 0.2% Remains Within DRV of 0.7-8.4%	5.9%; Decrease: 0.1% Remains Within DRV of 0-18.1%
		Average patch size of dry and moist forest structures in the Buttermilk and Libby landscapes. (acres) .	**Dry Forest**		
			Structure	**Buttermilk**	**Libby**
			OFMS	0.5%; No Immediate Change Remains Within DRV of 0-5.6%	0.5%; No Immediate Change Remains Within DRV of 0-11.2%
			OFSS	0%; No Immediate Change Remains Within DRV of 0-5.3%	0%; No Immediate Change Remains Within DRV of 0-3.0%
			SECC	1.4%; Negligible Change Remains Within DRV of 0.4-5.6%	0.8%; No Change Remains Within DRV of 0-5%
			SEOC	0.4%; Increase: 0.2% Remains **Below** DRV of 2.5-12.3%	0.7%; Increase: 0.3% Remains **Below** DRV of 2.5-12.3%
			SI	0.3%; No Change Remains **Below** DRV of 0.9-8.9%	1.3%; Decrease: 0.1% Remains Within DRV of 0.9-9.9%
			UR	1.3%; Negligible Change Remains Within DRV of 1-10.3%	1.1%; Decrease: 0.1% Remains Within DRV of 1-18.4%
			YFMS	3.9%; Decrease: 0.2% Remains Within DRV of 0.7-8.4%	5.9%; Decrease: 0.1% Remains Within DRV of 0-18.1%
			Moist Forest		

Resource Element	Resource Indicator	Measure	Effects of Alternatives 2 and 3		
			Structure	**Buttermilk**	**Libby**
			OFMS	57 ac.; No Immediate Change Remains Within DRV of 0-312 ac	27 ac.; No Immediate Change Remains Within DRV of 0-348 ac
			OFSS	0 ac.; No Immediate Change Remains Within DRV of 0-255 ac	0 ac.; No Immediate Change Remains Within DRV of 0-213 ac
			SECC	107 ac.; Increase: 39 ac Remains Within DRV of 42-927 ac	26 ac.; No Change Remains Within DRV of 0-174 ac
			SEOC	52 ac.; Increase: 15 ac Now Within DRV of 50-249 ac	28 ac.; Increase: 7 ac Remains **Below** DRV of 50-249 ac
			SI	31 ac.; No Change Remains **Below** DRV of 32-177 ac	29 ac.; Increase: 2 ac Remains **Below** DRV of 32-177 ac
			UR	37 ac.; Decrease: 2 ac Further **Below** DRV of 68-246 ac	18 ac.; Decrease: 1 ac Further **Below** DRV of 68-383 ac
			YFMS	66 ac.; Decrease: 8 ac Remains Within DRV of 46-363 ac	85 ac.; Increase: 3 ac Remains Within DRV of 0-440 ac
	Forest patches with, large and medium size trees.	Acres treated in the Buttermilk and Libby landscapes to maintain and restore large trees in patches with medium, large, or large and medium size trees.	Buttermilk. Medium Trees – 284 acres treated of 14,867 ac available Large Trees - 182 acres treated of 2,391 ac available Large and Medium – 110 acres treated of 640 ac available		Libby Medium Trees – 2,958 acres treated of 8,142 acres available Large Trees – 122 acres treated of 321 acres available Large and Medium – 0 acres available

Resource Element	Resource Indicator	Measure	Effects of Alternatives 2 and 3		
Resilience to biotic natural disturbances.	Western spruce budworm vulnerability compared to the desired range of variability.	Percentage of the Buttermilk and Libby Creek landscapes with high, moderate, and low risk.	**Risk**	**Buttermilk**	**Libby**
			Low	16%; Increase: 1% Remains **Below** DRV of 22-28%	33%; Increase: 1% Remains **Above** DRV of 12-28%
			Moderate	19%; Increase: 4% Remains Within DRV of 13-33%	17%; Increase: 6% Remains Within DRV of 8-27%
			High	65%; Decrease: 4% Remains **Above** DRV of 31-52%	50%; Decrease: 7% Remains Within DRV of 29-74%
	Forest vegetation vulnerable to Douglas-fir bark beetles.	Acres of treatment in the Buttermilk and Libby landscapes with high or moderate risk.	Moderate - 1,111 acres treated (137 overstory treatment) of 6,061 acres available High - 2,384 acres treated (513 overstory treatment) of 4,463 acres available		Moderate - 2,615 acres treated (971 overstory treatment) of 11,820 acres available High - 1,237 acres treated (404 overstory treatment) of 2,532 acres available
	Forest vegetation vulnerable to dwarf mistletoe infection.	Acres treated in the Buttermilk and Libby Creek landscapes to reduce vulnerability.	Buttermilk = 3,351 (633 overstory treatment) of 6,349 ac. Available		Libby = 4,495 (1.305 overstory treatment) of 10,961 ac. Available

Figure 53. Post-project vegetation structure for Alternatives 2 and 3.



Note to reader: Page references provided in the Notice of Opportunity to Comment for the Mission Revised Preliminary EA may be off by one number in this excerpt from the full document.

3.5.4.3.2 Cumulative Effects

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis
There are no concurrent or reasonably foreseeable activities within the Mission Forest and Fuels Project area that would affect vegetation.

3.5.4.4 Summary of Effects

There is no difference between the two action alternatives. Under both alternatives Two and Three, the planned vegetation management treatments would move towards or maintain the Desired Range of Variability for Forest Vegetation Composition and Structure and vulnerability to western spruce budworm in both the Buttermilk and Libby landscapes. Both alternatives would considerably reduce the acres of high and moderate vulnerability to Douglas-fir beetles and treat acres vulnerable to Douglas-fir dwarf mistletoe. The planned treatments would maintain or promote medium and/or large trees on nearly 14% of the combined landscapes.

Figure 54. Summary of vegetation resource indicators for all alternatives.

Purpose and Need	Indicator	Measure	Alt 1	Alt 2 and 3
P & N #3 – Vegetation Composition and Structure	The amount and arrangement of dry and moist forest structures compared to the desired range of variability.	Percent Landscape	17 out of 28 Categories Within DRV	25 out of 28 Categories within or moving toward DRV
		Average Patch Size	18 out of 28 Categories Beneficial within DRV	28 out of 28 Categories Beneficial within or moving toward DRV
	Forest patches with large and medium size trees.	Acres treated	0	3,656
	Western spruce budworm vulnerability compared to the desired range of variability.	Percent Landscape In Low, Medium and High Vulnerability Levels	3 out of 6 categories within DRV	6 out of 6 categories within or moving toward DRV
	Forest vegetation vulnerable to Douglas-fir bark beetles.	Acres of treatment in the Buttermilk and Libby landscapes with high or moderate risk.	0	7,347
	Forest vegetation vulnerable to dwarf mistletoe infection.	Acres treated in the Buttermilk and Libby Creek landscapes to reduce vulnerability.	0	7,846

3.5.5 Consistency Statement

Compliance with LRMP and Other Relevant Laws, Regulations, Policies and Plans
Alternative 1 is in compliance with all LRMP, laws, regulations, policies and plans.

Both action alternatives meet Okanogan NF LRMP Forest-wide Standards and Guidelines (FW S&G) in that;

- FW S&G 5-1: No harvest would take place in mixed conifer old growth stands
- FW S&G 20-14: Commercial thinning would thin from below (generally leave the largest trees)
- FW S&G 20-15: Intermediate thinning would have a beneficial effect regarding the vulnerability to insects and disease.
- FW S&G 20-28: The Landscapes would be managed to maintain or promote historic composition of tree species.
- FW S&G 20-34: Pre-commercial thinning (understory treatments) would take place in overstocked stands.
- FW S&G 20-35: Pre-commercial thinning (understory treatments) would reduce and minimize the spread of disease or the favorable conditions for injurious forest insects
- FW S&G 20-41: No openings over 40 acres in size would be created.

Both vegetation management in both alternatives would meet Okanogan NF LRMP management direction for Management Area 5 in that stands would be managed to control insects and disease problems and vegetation management activities would meet visual quality objectives for roaded natural recreation by managing the foreground of FSR 4300,retaining natural form, line, color, texture, and pattern on the landscape. Direction for Management Area 14 would be met in that the proposed timber harvest is designed to perpetuate the Desired Range of Variability for vegetation. Direction for Management Area 25 would be met in that the landscape would be intensively managed using both even aged and uneven aged silvicultural practices, while protecting the land for other resources and stands with high levels of dwarf mistletoe would be treated.

Neither action alternative includes vegetation management treatment within Congressionally Reserved areas (Wilderness) or inventoried roadless areas.

Both action alternatives would meet Northwest Forest Plan Objectives for Matrix in that 15 percent of the units identified for Variable Retention Regeneration treatment would be left through the next rotation and would be comprised of forest patches from 0.5-2.5 acres in size.

Both action alternatives would meet Northwest Forest Plan Objectives for Riparian Reserves in that the proposed commercial and noncommercial stocking reduction of conifers would result in maintaining or promoting deciduous shrub and tree species as well as decreasing fuel levels that would make Riparian Reserves more fire resilient.

Both action alternatives would meet Northwest Forest Plan Objectives for Late Successional Reserves in that planned noncommercial treatments would reduce conifer encroachment in

aspen stands and open the canopy and reduce potential for crown fire and competition between trees, which would reduce the risk of habitat loss of the late/old habitat.

Forest Plan Amendment Effects on Substantive Provisions
To meet Purpose and Needs #2, #3, #4 and #6 identified in Chapter 1 of the EA, vegetation management treatments would reduce deer winter range cover below Okanogan National Forest Land Resource Management Plan Standard and Guidelines MA14-6A and MA26-6A, requiring a project-specific amendment. The 2012 Planning Rule as amended (36 CFR 219) requires consideration of how such an amendment would affect substantive provisions identified in the Planning Rule. With respect to vegetation, the following substantive provisions would be affected by the proposed amendment;

219.8(a)(1)(iv) System drivers such as wildland fire, and climate change, and the ability of terrestrial and aquatic ecosystems in the plan area to adapt to change; (v) Wildland fire and opportunities to restore fire-adapted ecosystems; and (vi) Opportunities for landscape scale restoration. Thinning on up to 746 acres as provided by this amendment would have a beneficial, short- to long-term, minor to moderate effect on system drivers such as wildland fire, insects and disease, climate change, the ability of terrestrial ecosystems to adapt to change, opportunities to restore fire-adapted ecosystems, and opportunities for landscape-scale restoration because thinning in deer winter thermal cover would create forest vegetation structure, overstory and understory species composition, and spatial patterns that are more similar to historical and predicted future conditions and more likely to experience low-severity fire behavior similar to historical conditions. The resulting vegetation structure would be less vulnerable to effects of climate change such as increased summer warming and drying because there would be less vegetation on the landscape competing for increasingly scarce water resources. Thinning as allowed by this amendment may include up to 54 percent of the planned commercial thinning treatments in Libby Creek. Most of these prescriptions are designed to promote dry forest restoration. Besides restoring historical patterns of forest vegetation on the landscape, thinning would maintain and promote medium and large trees [large saw old forest (LSOF)] by reducing stocking levels and reducing levels of dwarf mistletoe infection, all of which creates resilience to fire and insects and promotes ecological sustainability under current conditions and in those associated with projected climate change.

219.9(a)(1) Ecosystem Integrity: The 746 acres of additional vegetation management treatment associated with the amendment would have a beneficial, short to long-term, minor to moderate effect on ecosystem integrity because it would help restore forest structure towards historical composition and patterns that are more sustainable to disturbances such as insects and disease, wildfire, and projected impacts of climate change. Most of this treatment is within Libby Creek sub-watershed and represents up to 54 percent of the overstory treatment in that sub-watershed. Most of the vegetation management activity that would be involved with this reduction of deer winter range cover would be moving multi-storied stand structures (Young Forest Multi Story and Stem Exclusion Closed Canopy), which are over-represented in both Libby Creek and Buttermilk Creek sub-watersheds compared to historical conditions, to more open, single storied structure like Stem Exclusion Open Canopy and Stand Initiation. Levels of dwarf mistletoe would also be reduced. By returning to more historical stand structure and

composition, treated stands and the landscape in general would have an increased resilience to fire and insects. This would allow for future prescribed fire treatments which would increase the presence and diversity of understory species dependent on open stands and/or frequent fire intervals, but decrease the presence and diversity of species dependent on closed canopy stands and infrequent fire intervals.

3.6 Fire/Fuels

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Fire/Fuels Report by M. Trebon (2016), available in the project record. Reference information is contained in the full specialist report.

3.6.1 Methodology

Figure 55 describes the fuels and fire resource indicators that will be used to evaluate existing conditions in this project area and effects of proposed treatments.

Figure 55. Fire/Fuels Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Restoration or maintenance of fire behavior to within the desired range of variability.	The amount and arrangement of each type of crown fire risk as compared to the desired range of variability.	Percentage of Libby and Buttermilk landscapes in Low, Moderate, & High risk of crown fire	P&N #1 P&N #3 P&N #4	LRMP S&G NWFP S&G FSM Restoration Strategy FMP
		Average patch size (in acres) of Libby and Buttermilk landscapes in Low, Moderate, and High risk of crown fire		
Wildfire hazard in Wildland Urban Interface	Fire behavior in WUI	Percent of flame length by size class	P&N #6	LRMP S&G NWFP S&G FSM FMP CWPP
		Percent of fire behavior by type (none, surface, crown)		
	Fire behavior along FS Roads 43 and 4340	Percent of flame length by size class		

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
		Percent of fire behavior by type		
Access for vegetation and fire management	Roads in project area	Percent of FS roads greater than ½ mile in length that would remain or be decommissioned.	P&N #7	LRMP S&G

The methodologies used to analyze resource indicators are described below. Modeling results were interpreted using more than twenty-five years of local prescribed burning and fire suppression experience gained in similar terrain, fuel types, fuel loading, stand composition, and weather conditions.

Resource Indicators: The amount and arrangement of each type of crown fire risk in the Buttermilk and Libby Creek watersheds as compared to the desired level between historical and future ranges of variability.
The Restoration Strategy (Reynolds 2002; Reynolds et al. 2003; USDA 2012b) outlines the analysis process used to evaluate landscape conditions and assess whether landscape characteristics such as crown fire risk have departed from historic and/or future ranges of variability. The process involves conducting photo interpretation to identify multiple vegetation and landscape attributes in each of the two sub-watersheds in the project area: Buttermilk Creek and Libby Creek. The Ecosystem Management Decision Support (EMDS) modeling tool (EMDS 3.0.2, ibid) used these data to evaluate existing landscape and stand-level characteristics and trends separately for each sub-watershed. EMDS was used to compare the current conditions to a range of historical and future reference conditions for each sub-watershed to give insights into how vegetation and disturbance systems have changed and how they are likely to change over time.

In this analysis, crown fire risk (CFR) at low, moderate, and high levels (Appendix C in Huff et al. 1995) is the primary fire characteristic used to assess how fire behavior has changed from 80th percentile values for the historical range of variability (HRV) and the future range of variability (FRV). HRV refers to the fluctuations in ecosystem composition, structure, and process over time, especially prior to the influence of Euro-American settlers (USDA 2012b). FRV refers to expected fluctuations in these elements due to projected changes in climate (ibid). Crown fire risk describes the potential for a surface fire to transition into a crown fire, which increases fire severity (the effect of a fire on ecosystem properties, usually defined by the degree of soil heating or mortality of vegetation as indicated by vegetation mortality, habitat alteration, and other fire effects (Agee 1993).

CFR naturally exists at various levels in forest vegetation in the project area, and is influenced by vegetation structure, number of canopy layers, crown cover, weather, and surface fire behavior such as flame length (Huff et al. 1995). Vegetation characteristics in turn are influenced by temperature and moisture regimes. From a management perspective, changes in the type, amount, and arrangement of crown fire risk on the landscape may cause concern because some of the conditions that increase CFR (i.e. greater flame length, and denser, multi-level stands) contribute to uncharacteristic fire effects, more severe air quality degradation, greater difficulty in controlling a wildfire, and higher risk of stand-replacement wildfires in areas that did not usually experience this type of disturbance (ibid). Uncharacteristic fire behavior in this analysis is defined as fire frequency and effects in a given landscape that are departed from the historical natural fire regime's range for that landscape (Hardy et al. 1998). A historical natural fire regime is a description of the frequency and impacts of historical fire conditions under which vegetation communities evolved and were maintained without fire exclusion (Hardy 2005).

EMDS was used to classify CFR into low, moderate, and high levels in each sub-watershed. Each level of CFR was measured by the percentage of land to indicate the overall amount on the landscape, and by average patch size to indicate the arrangement of this fire behavior on the landscape. Patch size is a landscape ecology term defined as a relatively homogeneous area that differs from its surroundings; patches are the basic unit of the landscape that change and fluctuate through a process called patch dynamics (*https://en.wikipedia.org/wiki/Landscape_ecology, accessed 10/20/16).* HRV was determined by analyzing an ecosystem sub-regions (ESR) composed of similar climate, geology, topography, aquatic characteristics, and disturbance histories to the respective sub-watersheds in the project area (Huff et al. 1995; Hessberg et al. 1999; USDA 2012b). The future range of variability (FRV) was developed to provide insight as to how the sub-watersheds may be affected by changing climate. EMDS was used to model an ecosystem with landscape characteristics in the next warmer ESR than each sub-watershed as a conservative proxy for reference conditions under climate change (USDA 2012b). These outcomes are used in this analysis as the FRV. Because EMDS used a conservative approach in estimating climate change, it may underestimate the FRV if the degree of climate change is more severe than indicated by the next warmer ESR.

The desired values for CFR at each level were determined by finding where the HRV and FRV overlap; this intersection is called "the desired range of variability" in this analysis. The landscape prescription for CFR was developed based on the need to maintain this fire behavior characteristic within this intersecting range, or to move this characteristic closer towards the intersecting range where it is outside of this value. Potential treatments were developed to alter the conditions that affect CFR, including prescribed fire and thinning, while recognizing that terrain and weather (other factors that influence crown fire behavior) cannot be changed. Treatment locations were developed in ArcGIS to apply the landscape prescription based on departure from the desired CFR range, field reconnaissance, discussion with resource specialists, and public input. Where at least 50% of the EMDS vegetation polygon was within a proposed treatment unit, changes were made to crown fire risk, flame length, and other vegetation characteristics depending on the type of treatment proposed to emulate their effects

on CFR. The resulting dataset was modeled by EMDS and compared to the HRV and FRV to determine whether the proposed treatments and locations would degrade, maintain, or improve the amount and arrangement of each level of crown fire risk in comparison to the HRV and FRV. Using a 50% breakpoint to select polygons affected by proposed changes will slightly underestimate changes in the project area where less than 50% of the polygon was not affected by a proposed treatment.

A small portion of the project area (205 acres) lies outside of the Buttermilk and Libby Creek watersheds, but within the greater Twisp River watershed. This area was added to the project at the request of adjacent residents in the Buttermilk Firewise Community, and is referred to in this analysis as the Buttermilk Annex. The purpose of proposed treatments in this area is based on the need to reduce fire hazard created by the volume, condition, arrangement, and location of fuels in this area of WUI. The area was added to the project area after photo interpretation and initial EMDS modeling had been completed for the rest of the project area. For these reasons, this portion of the project area was not analyzed with EMDS for consistency with HRV or FRV of any comparable ESR.

Resource Indicator: Fire behavior in WUI

Wildfire risk is defined as the combination of likelihood, intensity, and effects of wildfires. (Scott et al. 2013). In this analysis, two fire characteristics that contribute to wildfire intensity were analyzed: crown fire behavior and flame length. For the purposes of this analysis, Wildland Urban Interface (WUI) consists of the area described by the CWPP, including two priority treatment areas identified by the CWPP that lie within the project area boundary. Fire behavior in the WUI was evaluated by modeling the existing type of fire behavior (surface or crown) and flame length, fire characteristics that affect wildfire risks to life and property and allow or limit the use of direct suppression opportunities. FlamMap 5.0 software (Finney 2006) was used to spatially model these elements at the stand level under constant weather conditions to determine current values and those expected post-treatment under the modeled conditions. FlamMap modeling used data from LANDFIRE (LANDFIRE 2010, LANDFIRE 2012) to create a 30-meter grid over the project area, with each cell of the grid assigned an elevation, slope, aspect, canopy height, canopy cover, crown base height, crown bulk density, and surface fuel model. The resulting data were clipped to the WUI in the project area using ArcGIS software.

Weather data used in modeling came from the Douglas Ingram Ridge (DIR) Remote Access Weather Station (RAWS), located nine miles southeast of the project area. This RAWS was selected because it is the closest station at a similar elevation and aspect to the project area. Data from the DIR RAWS cover a 20-year period from 1985 to 2016, with hourly readings of temperature, relative humidity, dead and live woody fuel moistures, and herbaceous fuel moistures used in this analysis. Errors and omissions in this data were corrected against the Leecher Mountain and North Cascades Smokejumper Base RAWS. FireFamilyPlus 4.0 software (Bradshaw and McCormick 2000) was used to calculate 90th percentile weather conditions from this data for input to FlamMap. This percentile was selected because it represents the conditions most prevalent during fire growth, excluding 10% of the more severe conditions such as wind events or drought that contribute to extreme fire behavior. Testing proposed treatments against 90th percentile conditions gives a good indication as to whether

treatments have the potential to affect fire behavior during the conditions under which most fires grow. Treatments proposed by this project are not intended to effectively change fire behavior past 90th percentile weather as these environments include low humidities, high temperatures, and winds that create fire behavior that is difficult to alter with fuels treatments.

Winds can accelerate fire characteristics dramatically, but for this analysis, fire behavior was modeled in FlamMap with no wind to show baseline crown fire activity without its influence. Historical wind data from nearby RAWS are available in the analysis file for indications of the wind speeds and directions typical of the area. FlamMap made relative fire behavior calculations for each cell in the grid, assuming that each one burns independently and simultaneously. By creating a static representation of the landscape where there is no predictor of fire movement across the landscape and wind and weather values are constant, FlamMap output is useful for comparing landscapes and treatment effects, and for identifying hazardous fuels and topographic combinations (Stratton 2006). However, this modeling process may underestimate fire behavior due to modeling limitations (for example, it does not consider fire growth through spotting, and keeps interactions between fire, fuel and weather static).

The values used in this analysis will underestimate fire behavior during the latter part of the fire season (approximately late August - September) when fuels are drier, during drought conditions when fuels have cured sooner and more fully than expected, or during windy periods (especially when wind and slope direction align). Modeling parameters and data sources used in this analysis are described in detail in the Fuels/Fire Resource Report (Trebon 2016) in the project file.

Crown Fire Behavior in WUI: If wildfires move from the surface into the forest crown, they become more difficult to attack directly with personnel or equipment because fireline intensity increases, rates of spread can outpace available resources, and hazards to personnel increase. In addition to these concerns, crown fires promote more rapid fire growth by producing embers that may spot miles away (Koo et al. 2010). FlamMap determined fire behavior values for each grid cell as none, surface, passive (single or small groups of trees are involved) or active (where a solid flame develops in the crowns of trees, but the surface and crown phases advance as a linked unit dependent on each other). This analysis groups passive and active crown fire together in recognition of the modeling limitations of FlamMap, which under-represents crown fire, and because differentiating between the types of crown fire has limited value when the outcome in either case is ultimately the loss of the tree canopy (Scott and Reinhardt 2001; Stratton 2004) with greater potential for higher fireline intensity, resistance to control (defined as the relative difficulty of constructing and holding a control line as affected by resistance to line construction and by fire behavior; NWCG 2001), and more rapid, widespread fire growth through spotting.

The aspect of crown fire behavior most affected by proposed treatments in this project is the surface fuel loading and crown base height (CBH), the lowest height above the ground above which there is sufficient canopy fuel to propagate fire vertically (Scott and Reinhardt 2001). In general, surface fuels combine with slope to create flame lengths that may ignite lower branches; lower CBH values indicate greater susceptibility to ignition that initiates crown fire.

Lowering surface fuel loading through underburning, and raising the CBH through scorching lower branches (as may occur during underburning) or thinning the understory (as occurs during ladder fuel reduction thinning and pruning) reduces the risk of crown fire initiation because surface fires have less ground fuel and less canopy fuel to ignite directly (Agee and Skinner 2005). For this analysis, changes to CBH and resulting crown fire behavior were modeled by changing the surface fuel values and reducing the minimum CBH value within proposed treatment units to 4 meters (12 feet) to simulate the reduction of surface fuels and small-diameter trees through proposed understory thinning and pruning, and scorching of lower branches through proposed prescribed fire treatments.

Flame Length in WUI: In addition to influencing crown fire initiation, flame lengths affect the ability to use direct suppression tactics on wildfires in WUI, which in turn affects the size of the fire. Lower flame lengths may be approached more directly by personnel and ground equipment to contain and suppress wildfires, while longer flame lengths become inapproachable by these resources and must be contained and suppressed indirectly. FlamMap used fuel models and associated fuel loading combined with CBH values and weather parameters to predict flame lengths, which are compared below to established categories (Andrews and Rothermel 1982) that indicate likely suppression responses dictated by flame length. Because FlamMap works with gridded 30m data that doesn't allow precise translation to the general categories below, an adjusted range is used in this analysis that is allows for an approximation of the same conditions (to a wildland firefighter, a 3.3 flame length is barely distinguishable in intensity from a 4' flame length, and so on for the remaining categories)

- 0 to 4 feet: Personnel can generally attack fire directly at the head or flanks of the fire using hand tools. Hand fireline should hold the fire effectively. (For this analysis, this category will be called Low and include values from 0 to 3.3 feet.)
- 5 to 8 feet: Fires are too intense for direct attack on the head by personnel using hand tools. Hand fireline will not reliably hold the fire. Equipment such as plows, dozers, engines, and retardant aircraft can be effective. (For this analysis, this category will be called Moderate and include values from 3.4 to 9.8 feet.)
- 9 to 12 feet: Control efforts at the head of the fire will probably be ineffective. Personnel and equipment are unable to attack the fire directly. Retardant may be effective. (For this analysis, this category will be called High and include values from 9.9 to 13.1 feet.)
- Greater than 12 feet: Control methods at the head or directly adjacent to the fire are ineffective. Personnel, equipment, and retardant are ineffective. Indirect attack methods must be used, in which the control line is located some considerable distance away from the fire's active edge. (For this analysis, this category will be called Extreme and include values from 13.2 feet or greater.)

Resource Indicator: Fire hazards along FS Roads 43 and 4340

Forest Service Road 4300000 (referred to as FS Road 43 in this analysis) is the primary ingress/egress route for the project area, with 15.7 miles traversing both sub-watersheds to connect with adjacent county roads. Approximately 3.9 miles of Forest Service Road 4340000 (referred to as FS Road 4340 in this analysis) provides another primary route linking Libby Creek to the adjacent Gold Creek drainage. These two roads offer important ingress/egress

option for nearby residents, forest visitors, and suppression resources. During a wildfire, the safest conditions along these roads would be created by conditions that support low flame lengths and as little crown fire as possible. These conditions also increase the likelihood of successfully using these roads as control points during a wildfire. Given that these roads go through many forested areas, a 150' buffer was created around these road features in ArcGIS to detect the type of conditions created by torching trees within 1 to 2 tree lengths of the road. The results of the FlamMap modeling described above were clipped to this buffer for comparison.

Resource Indicator: FS Roads in Project Area > 0.5 miles
The ability to treat vegetation, apply prescribed fire, and respond to wildfires on NFS lands in the project area is affected by road access. Roads that would remain open or allow Administrative Access post-project would provide rapid access to areas for these purposes. Post-project road closures would limit access by vehicles for vegetation and prescribed fire treatments, but would still be available for future access to conduct vegetation and fuels management activities. Closed roads would increase the response time for engines because the road barrier would need to be removed by machinery before emergency access would be possible. Road decommissioning would eliminate vehicle access for ongoing vegetation and prescribed fire treatments and suppression response, and limit the type of resources that may be used to respond to wildfires.

This indicator will compare the miles of roads greater than 0.5 miles that remain post-project to those that would be decommissioned. ArcMap was used to determine the miles of roads in each category for each alternative. Changes to roads that are less than 0.5 miles long are not included in this analysis because they access relatively small portions of the landscape that have access from other roads, or access areas with limited need for vegetation management, or offer little effective access for fire management.

3.6.2 Intensity Level Definitions
The following definitions will be used to describe the types of impacts that would be caused by proposed actions analyzed in this report.

Type of Impact:

- Adverse: increases the likelihood of uncharacteristic fire behavior and/or risk to developments; reduces access for vegetation/fuels & fire suppression activities.
- Beneficial: decreases the likelihood of uncharacteristic fire behavior and/or risk to developments; maintains or increases access for vegetation/fuels & fire suppression activities.

Duration of Impact:

- Short-term: Impact lasts up to 15 years.
- Long-term: Impact lasts more than 15 years, or (in the case of road decommissioning) is permanent.

Intensity of Impact:

- None: No impacts

- Negligible: Undetectable change to plant community structure, composition, and/or fuels that shifts fire behavior and ecological functions; minimal impacts to WUI; or access for fuels & fire management changed by less than 10 percent.
- Minor: Slightly noticeable, localized change to plant community structure, composition, and/or fuels that shifts fire behavior and ecological functions on up to one-third of the project area. Noticeable impacts to up to 33% of WUI. Access for vegetation and fire management changes by 11-25%.
- Moderate: Apparent change in plant community structure, composition, and/or fuels that shifts fire behavior and ecological functions on one-third to half of the project area; impacts to 33-66% of WUI; or access for vegetation and fire management changed by 26-40%.
- Major: Substantial change in plant community structure, composition, and/or fuels that shifts fire behavior and ecological function across more than 50% of the project area; impacts to over 66% of WUI; or access for vegetation and fire management changed by more than 40%.

3.6.3 Affected Environment

Overview of crown fire risk

Historically, the areas within the project sub-watersheds that experienced low CFR occupied the hot-dry and warm-dry forest areas in the northern portion of the Buttermilk Creek drainage and the northern and eastern portions of Libby Creek drainage. Fire frequency and severity in these environments were typical of Fire Regime I, where fire-return intervals ranged from 0 to 35 years with mostly low-severity fires that replaced < 25% of dominant overstory vegetation (Hardy et al. 1998; Hann and Strohn 2001; Hann et al. 2003). Forest stand structure in these areas would have been more open because wildfires that consumed surface fuels also killed smaller seedlings and saplings and scorched lower tree branches, keeping the likelihood of surface-to-crown fire transition low. Crown fire would have been the exception, with larger trees being highly resilient to wildfire because low-severity wildfire would have been less likely to reach higher tree canopies or penetrate the thick bark common to the dominant tree species of this area. As described in the Vegetation specialist report, past timber harvest in the sub-watersheds have altered the response to wildfires by reducing the proportion of fire-tolerant forest cover types that have been replaced with more shade-tolerant species. This change also caused an increase in tree canopy cover and lowered canopy-base-heights in many dry forested areas, allowing surface fires to more readily carry into overstory crowns. Harvest removed many of the large fire-resistant trees, leaving younger trees that are less tolerant to fire because of thinner bark and lower canopy base heights. Other management activities such as fire suppression (that allowed accumulation of surface fuels and development of understory tree layer) and pre-1970s grazing practices (that created bare soil over large areas and fostered germination of seedlings) helped many of dry forested areas in the Buttermilk drainage to develop a greater CFR than historically. Surface fires have a greater likelihood of transitioning into crown fire, causing uncharacteristic adverse fire effects such as more widespread tree mortality and attendant adverse effects on wildlife and aquatic habitat. Because many of the areas that typically had low CFR now have moderate or high CFR, more of this landscape is at

risk for uncharacteristically severe wildfires with detrimental effects to hydrologic and soil processes, as well as terrestrial and aquatic habitat.

Areas of moderate CFR historically occupied the cool-dry portions of the sub-watersheds and generally experienced mixed-severity fire behavior typical of Fire Regime III, where fire-return intervals ranged from 35 to 200 years (ibid). Mixed-severity fire behavior would have included a mosaic of low to high fire severity. These areas generally lie in mid-elevation in the project area (approximately 3000-4000') and/or on north aspects. Areas of high CFR historically occupied the cool-moist portions of the sub-watersheds that generally lie at higher elevations (approximately 4000' or more) or along narrow perennial stream channels; these areas historically experienced high-severity, or stand-replacement, fires typical of Fire Regime IV, where fire return intervals ranged from 35 to 200 year-intervals (ibid).

The existing measures for the fire/fuels resource indicators are displayed in **Figure 56**.

Figure 56. Fire/Fuels Resource Indicators and Measures for the Existing Condition

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
Restoration or maintenance of fire behavior to within the desired range of variability.	The amount and arrangement of each type of crown fire risk in the Buttermilk Creek and Libby Creek watershed as compared to the desired range of variability.	Percentage of landscape in Low, Moderate, & High risk of crown fire	LOW CFR Buttermilk = 32% Below desired range of 45-67% Libby = 53% Within desired range of 41-67%
			MODERATE CFR: Buttermilk = 27% Within desired range of 20-30% Libby = 32% Within desired range of 20-36%
			HIGH CFR: Buttermilk = 41% Above desired range of 12-28% Libby = 16% Within desired range of 5-24%
		Average patch size in Low, Moderate, and High risk of crown fire	LOW CFR Buttermilk = 207 ac Below desired range of 1651-3714 ac Libby = 400 ac Below desired range of 713-3714 ac

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
			MODERATE CFR: Buttermilk = 305 ac Below desired range of 460-2073 ac Libby = 268 ac Below desired range of 460-1776 ac
			HIGH CFR: Buttermilk = 1504 ac Within desired range of 523-2125 ac Libby = 248 ac Within desired range of 242-934 ac
Wildfire hazard in Wildland Urban Interface	Fire behavior in WUI (23,000 acres total)	Percent of flame length by size class Percent of fire behavior by type	Low: 52% Moderate:35% High: 4% Extreme: 9% None: 3% Surface: 82% Crown: 15%
	Fire behavior along FS Roads 43 and 4340 (701 acres total)	Percent of flame length by size class Percent of fire behavior by type	Low: 85% Moderate: 9% High: 2% Extreme: 4% None: 28% Surface: 61% Crown: 11%
Access for vegetation and fire management	FS Roads in project area.> 0.5 miles (99.3 miles total)	Percent of FS roads greater than ½ mile in length that would remain or be decommissioned.	Remain: 100% Decommissioned: 0%

Resource Indicator: The amount and arrangement of each type of crown fire risk in the Buttermilk Creek watershed as compared to the desired range of variability.
Current CFR in the Buttermilk Creek and Libby Creek drainages is shown in **Figure 57** below. The Buttermilk Creek drainage has less area with low CFR than desired, which means that more of the forested area in this sub-watershed lies in moderate or high CFR with greater likelihood of uncharacteristic fire behavior and effects. The amount of Buttermilk Creek with moderate CFR is within the desired range, allowing room to treat these areas to maintain

vegetation characteristics that improve resiliency to wildfire. High CFR occupies more of this drainage than is desired, dominating locations where low-severity wildfire was common historically.

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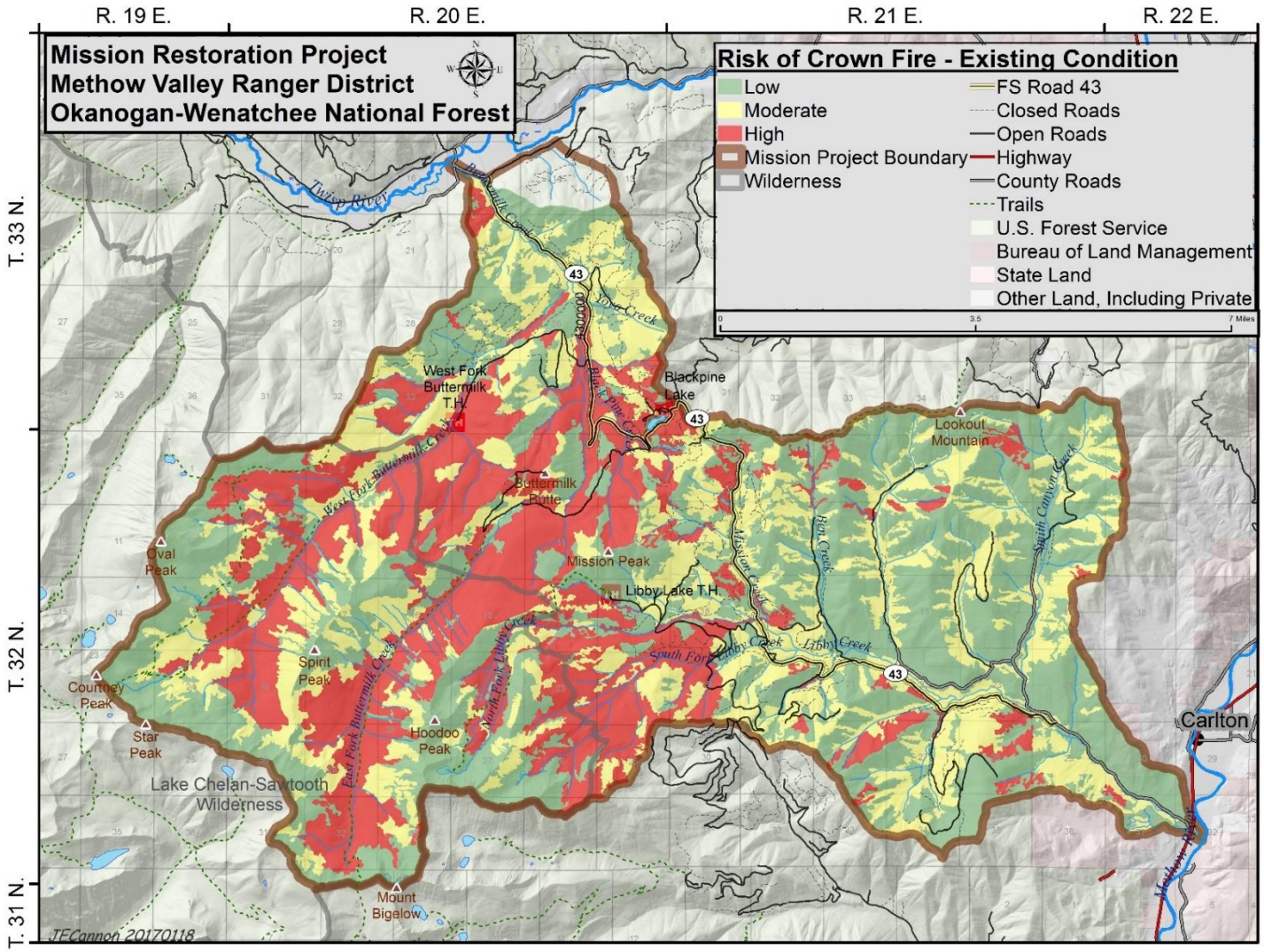
Figure 57. Existing risk of crown fire in the project area.



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The average patch size of areas with low CFR in the Buttermilk drainage is well below the desired range, and areas of moderate CFR are slightly below the desired range. These types of CFR are fragmented into smaller pieces than desired, and, during a wildfire, would be more likely to be overcome by the type of fire disturbance occurring in adjacent patches. For example, smaller patches that historically experienced low CFR lie adjacent to patches with moderate or high CFR that are more likely to support and transfer uncharacteristic fire behavior and effects into and through the patches of low CFR. Since areas with moderate CFR historically experienced mixed-severity fire behavior that included low and high fire severity, being influenced by fire behavior in adjacent patches with low or high CFR would cause effects within the range of historical fire behavior of this crown fire type. The patch size of high CFR is within the desired range. The dominance of high CFR around smaller patches of low and moderate CFR makes these areas vulnerable to uncharacteristic wildfire behavior with high likelihood of more severe fire behavior and effects than desired.

Another consideration for patch size is how it influences post-disturbance recovery rates. Ecological properties of a patch are influenced by the surrounding neighborhood, and the magnitude of these influences are affected by patch size and shape (McGarigal et al. 2012). The recovery process for species removed by a disturbance (like wildfire) is closely connected to the dispersal capability pf that species and the distance between the disturbed site and surviving source populations (Paine 2012). The ponderosa pine and Douglas-fir tree species at risk for mortality in areas with low CFR have seeds that are too large to be transported great distances, and their post-fire recolonization rate and success is heavily influenced by proximity to seed sources. If uncharacteristic fire behavior causes increased mortality in larger patches that cross low, moderate, and high CFR, trees would be slower to recolonize because of distance from seed sources. When subsequent disturbances continue to occur during its recovery period, they create conditions that can lead to the formation of alternative vegetation communities (ibid). A local example of this lies adjacent to the project area in the boundary of the 2001 Libby South Fire that burned again in the 2014 Carlton Complex fire. The 2001 fire created a large patch of high-severity fire in a hot-dry, warm-dry forested area that would have experienced frequent, low-severity fires historically. Conifer seedlings had started to naturally colonize the edges of this burned area and were replanted in other small portions, but outside of these locations, herbaceous cover (grass and shrubs) dominated the area. When the area burned again in 2014, many of these seedlings were killed and the patch size of high-mortality fire was enlarged further into adjacent stands of mature Douglas-fir and ponderosa pine, creating more distance from seed sources.

The length and severity of wildfire seasons across the Western U.S. is expected to increase (Liu et al. 2010; Climate Central 2012; Westerling et al. 2006). The project landscape is predisposed to burning in the dry summer climate (Agee and Skinner 2005) and, coupled with the normal pattern and frequency of lightning ignitions, makes wildfires a certainty, not a possibility. Fire frequency and behavior would be exacerbated by anticipated likely climate changes such as reduced snowpack with earlier melt-off, drought, longer summer weather conditions, and lower stream flow levels. This would create conditions that allow fuels to dry out earlier and more completely, adding to available fuels for wildfires (Millar et al. 2007). The combination of these factors create the strong possibility for more frequent fires with potential for ignition over a longer period of the growing season and greater likelihood for a recently disturbed area to experience another disturbance before recovery is complete.

Resource Indicator: The amount and arrangement of each type of crown fire risk in the Libby Creek watershed as compared to the desired range of variability.
The proportions of the landscape occupied by low, moderate, and high CFR in Libby Creek are within the middle or high end of their desired ranges. The areas with low and moderate CFR would benefit from further treatments to help maintain or improve resilience to wildfire without moving these characteristics outside of the desired ranges. However, the arrangement of low and moderate CFR is undesirable because each type is fragmented into too many small patches that lie close together, making them more vulnerable to more severe type of disturbance occurring in adjacent larger patches and possibly affecting their post-fire recovery as described for the Buttermilk Creek drainage above. In several location, smaller patches of low CFR lie adjacent to moderate or high CFR, indicating a high potential for uncharacteristic fire behavior and effects from the more dominant patches. Similar to Buttermilk Creek, the areas with the most departure from the desired range lie in the dry forested portions of the drainage that would have experience similar fire behavior as described for Fire Regime I.

Resource Indicator: Fire behavior in WUI
The project area contains approximately 23,000 acres of WUI as defined in the CWPP (see **Figure 58**). About 16,400 acres of this amount is identified in the CWPP as Rural WUI; most of this lies in the Libby Creek drainage with a small portion in the Buttermilk Creek drainage around Blackpine Lake Campground. About 5000 acres of WUI within the project area is part of the CWPP's "Twisp-Carlton Neighborhoods" and is characterized in the CWPP as having moderate to high risk of wildfires, especially on mid- to upper-slopes and in developed drainages. Within this area, the CWPP further identifies Libby Creek as a potential "hot spot" for fire activity due to economic values, fuel types, fire history, and access issues. The project area also contains approximately 1600 acres of WUI in the Buttermilk Creek vicinity is in another priority treatment area, the "Twisp River Neighborhood", and is characterized in the CWPP as having very high risk of experiencing a damaging wildfire in part because of existing fuel types, fuel loading, and topography. Recommended treatments in both areas include fuel reduction around private lands and along ingress/egress routes.

FlamMap modeling under 90th percentile conditions with no wind indicates that approximately 15% of the WUI within the project area is at risk for crown fires, and 58% of the WUI is likely to experience moderate to extreme flame lengths. Large patches of crown fire risk exist in the Libby Creek drainage adjacent to private lands with developments. Crown fire risk and flame lengths would likely increase during an actual wildfire because fires often occur during windy periods that accelerate fire behavior; when winds align with slope direction, these values would increase at an even greater rate. Risks to developed areas increase with longer flame lengths and increase crown fire because these types of fire behavior generate more fire intensity that limit direct attack options and produce firebrands that are lofted in the fire's convective column, providing potential ignitions sources as they land. Greater flame lengths also increase risk for firefighters, limit direct attack opportunities, and increase the risk of wildfires moving off NFS lands to private lands (or vice versa). When direct attack options are limited, fire growth may continue unabated until suppression resources find and prepare a suitable barrier, or wait until the fire behavior diminishes enough to attack directly. Private lands in the project area generally

lie at the bottom of drainages and, while some landowners have reduced fuels and used Firewise principles in building materials and landscaping, the risk of a wildfire on private lands moving on to NFS lands still exist. **Figure 58** shows current fire behavior in the WUI under modeled conditions.

Resource Indicator: Fire behavior along FS Roads 43 and 4340
Approximately 21 miles of FS Roads 43 and 4340 lie within the project area. During the 2014 Carlton Complex wildfire, some understory thinning and pruning occurred within 25 to 50 feet of approximately 7 miles on the south side of FSR 43. This work, performed with restricted time and resources during fire suppression efforts, created a narrow buffer along one side of this road that where wildfire behavior would likely be reduced, but the potential for crown fire initiation exists just beyond this narrow buffer because fuel continuity from the surface to understory trees with low branches to the overstory tree canopy above the road still exists. Crown fire initiation within 50' of these roads would have a strong potential to carry fire over the road or increase fire intensity, either of which would limit use of these roads during a wildfire.

Buffering these roads by 150 feet on either side to model fire behavior adjacent to the roads created an area of 701 acres. FlamMap modeling under 90th percentile conditions with no wind indicates that approximately 11% is at risk for crown fires, and 15% is likely to experience moderate to extreme flame lengths. These values would likely increase during an actual wildfire because fires often occur during windy periods that accelerate fire behavior; when winds align with slope direction, these values would increase at an even greater rate. The smaller areas of greater fire behavior are interspersed between areas of surface fire with low flame lengths, but even a small area of crown fire or moderate to extreme flame length could serve to block ingress or egress to the area, create greater risks to those using the roads, limit direct attack options, and produce firebrands that are lofted in the fire's convective column, providing potential ignitions sources as they land. As use of these roads becomes limited by fire behavior, nearby residents, forest visitors, and suppression resources may be unable to leave or access the area as needed.

Resource Indicator: FS Roads greater than 0.5 miles
The project area contains approximately 134.6 miles of roads on National Forest System (NFS) lands. Of these roads, 99.3 miles are at least 0.5 miles long and access substantial areas for vegetation or fire management. Whether open or closed, these roads maintain access to several key locations in the project area and are important for continuing vegetation management, prescribed fire treatments, and fire suppression, especially where these roads provide substantial access to WUI, ridgelines, and midslope hillsides. About 54% of these roads are currently open, providing continual access, while the remaining 46% are closed and can be re-opened rapidly during emergency fire response, or remain closed until future management needs require access. Roads on the project landscape provide for more rapid fire suppression access with a wider range of options, including the potential use of equipment such as engines and tenders. Both open and closed roads provide options for containment lines and escape routes.

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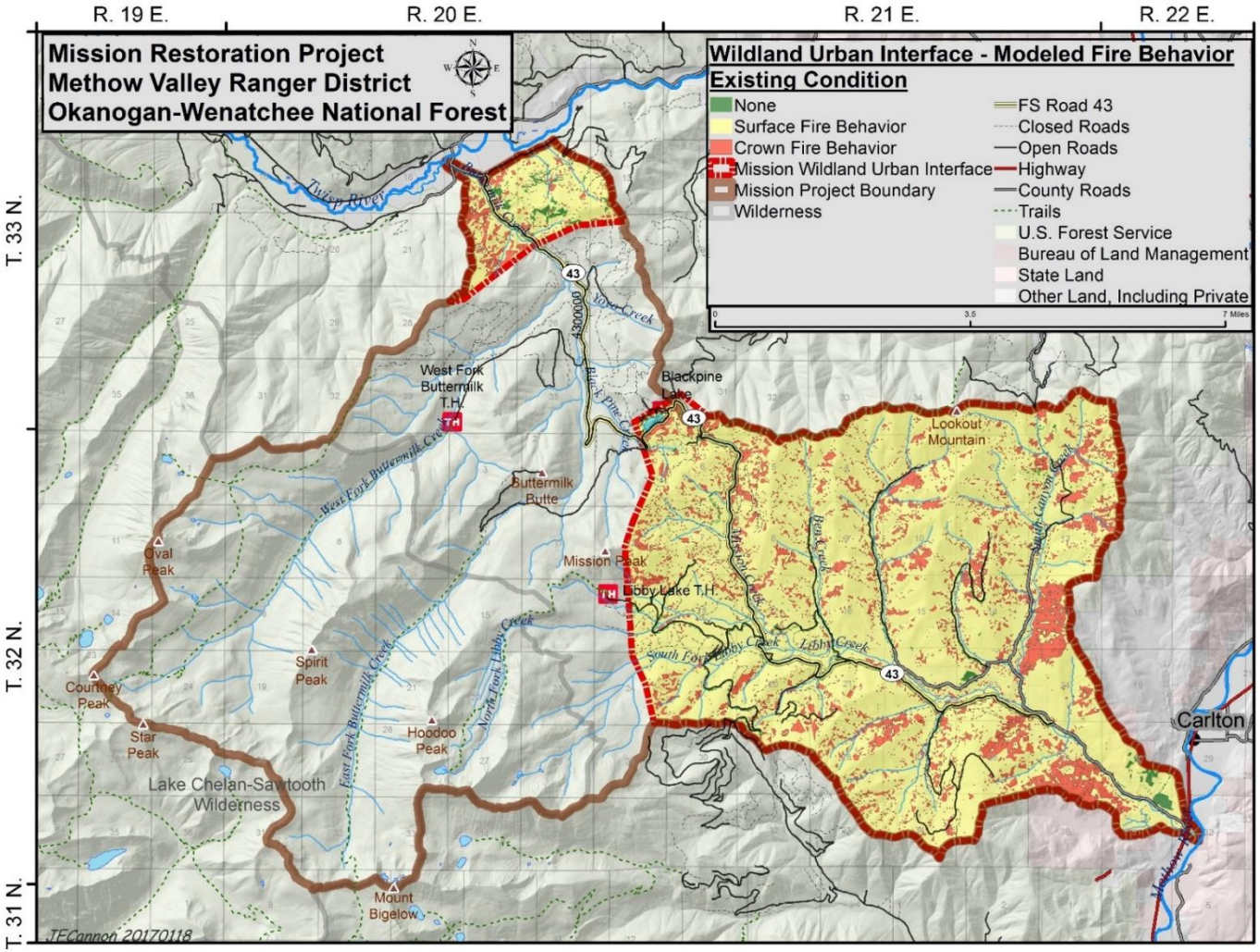
Figure 58. Existing condition of modeled fire behavior in the Wildland Urban Interface.



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In one area across the bridge over the West Fork Buttermilk Creek, approximately 10.7 miles of roads greater than 0.5 miles are currently designated as closed because the bridge accessing these roads was closed due to safety concerns around 2011. The bridge has not yet been replaced, leaving these roads closed because of circumstance and not because of resource concerns supported by an environmental analysis and subsequent decision. The condition of the bridge limits efficient and effective land management access on approximately 920 acres of NFS lands; as long as these roads remain closed, future treatment options will be limited. Suppression options in this area are currently restricted because equipment such as engines, tenders, or dozers cannot access this area. Wildfire response here will likely rely heavily on limited aerially delivered resources such as smokejumpers or rapellers, and when these resources are not available, ground resources will require a longer response time to access much of the area. The limitation on vehicles makes the road less useful as a rapid escape route, further narrowing suppression response options in this area during wildfires.

3.6.4 Environmental Consequences

3.6.4.1 Considered, but not Analyzed in Detail

The following proposed actions will not be considered further in this analysis because they would have no measurable effect on restoration or maintenance of CFR to within the desired range of variability, changing wildfire risk in the WUI, or altering access for vegetation and fire management: soil restoration; rock armoring; replacing undersized culverts or installing fish culverts; beaver habitat or coarse woody debris enhancement; or creating hardened fords.

3.6.4.2 Alternative 1

3.6.4.2.1 Effects

Resource Indicator: The amount and arrangement of each type of crown fire risk in the Buttermilk Creek watershed as compared to the desired level between historical and future ranges of variability.

If no action is taken to increase the amount and average patch size of low CFR levels and decrease the amount of high CFR in dry forests, then these areas would likely experience adverse, long-term, minor to major effects from uncharacteristic, high-severity wildfire behavior. The direction and amount of departure will likely increase because projected wildfire behavior and climate impacts would likely cause uncharacteristically severe impacts that further shift the type and amount of departures away from the desired range. The resilience of dry forested areas in the landscape would decline further because areas dominated by high CFR would influence wildfire behavior in adjacent uncharacteristically smaller patches of low CFR, causing unusually severe fire effects to be more widespread than historically. Terrestrial and aquatic habitat would have a strong likelihood for negative impacts including loss of vegetation and browse. Surface fuels and live vegetation would continue to increase over time until affected by wildfires, or other disturbances.

Areas of moderate CFR would experience short-term to adverse, long-term, minor to moderate effects as depending because their spatial distribution in the project area makes them vulnerable to more severe behavior from adjacent areas with high CFR. Rather than experiencing a range of fire severity, these areas are at risk of experiencing more crown fire behavior with greater rates of vegetation mortality during wildfires with adverse impacts to aquatic and terrestrial habitat. Vegetation recovery would likely take longer because of the potential for more severe fire effects over a larger area that decreases proximity to seed

sources. Smaller patches of low to moderate CFR would be less likely to sustain characteristic types of fire behavior and would be more likely to be influenced by adjacent, more severe types of wildfire. Many streams and forested stands in the drainage provide direct habitat for Threatened or Endangered species or connect to this habitat, and lie within or adjacent to areas where the amount and arrangement of low CFR is outside of the desired range. Past studies suggest substantial continuity in fire disturbances between sideslope and adjacent riparian forests (Everett et al. 2003). While some wildfires in the pre-suppression era may have stopped when reaching more moist riparian areas, the likelihood of stream channels providing an effective change in burning conditions that may stop or diminish fire behavior decreases on a landscape with an uncharacteristic tendency toward higher CFR. Many streams are surrounded by continual vegetation from just above the forest floor through multiple canopy layers on both sides of the stream, increasing available fuel for wildfires occurring on adjacent patches with high CFR to carry fire through riparian areas. Increased mortality that is likely to accompany crown fires would have greater potential to reduce shade along streams, increasing water temperature. Uncharacteristically high-severity fires would likely result in the loss of more vegetation across a larger portion of this drainage, increasing the chance that post-fire runoff would carry greater loads of sediment to streams and compromising aquatic habitat.

Given proximity to WUI and other resource values, it is highly likely that fire suppression will continue in the project area, especially given the level and direction of departure in CFR levels and the potential for undesirable fire behavior and effects. When ignitions occur, current LRMP and NWFP standards and guidelines and fire management policies require consideration of the values at risk, including human lives and developments and terrestrial and aquatic habitats. In some areas within the project boundary, management direction requires that fires be kept as small as possible when feasible. Therefore, the option of using wildfires to help move CFR levels into the desired amount and arrangement on the landscape is not currently viable Wildfires would be more likely to result in an adverse, long-term, moderate impact to dry forests in the sub-watershed. As a result, taking no action would not meet Purpose and Needs #1, #3, or #4.

Resource Indicator: The amount and arrangement of each type of crown fire risk in the Libby Creek watershed as compared to the desired level between historical and future ranges of variability.

Without intervention, the amount of this landscape at each level of low, moderate, or high CFR would likely remain within the desired range until affected by wildfire, insect and disease outbreak, and/or climate impacts such as drought. However, since areas with low and moderate CFR are below the desired range, they would be more at risk to experience the type of disturbance occurring in the patch with the more dominant type of CFR. Areas with small patches of low CFR that lie adjacent to areas of high CFR would be more likely to experience uncharacteristic high-severity fire. Wildfires would be more likely to result in an adverse, long-term, moderate to major impacts to dry forested areas within the sub-watershed. As a result, taking no action would not meet Purpose and Needs #1, #3 or #4.

Resource Indicator: Fire behavior in WUI
The result of taking no action in WUI to reduce fire hazard would be adverse, long-term, moderate impact on fire behavior because the risk of crown fire initiation would continue to grow due to ongoing fire suppression in around the WUI. In addition, natural processes would continue to allow accumulation of dead fuels and live vegetation faster than natural decomposition in this predominantly dry ecosystem could remove it. The risks to developed areas that accompany increased flame lengths and crown fire behavior would continue to exist, with fire intensity that limits direct attack options, torching that produces firebrands that contribute to spotting, and overall fire behavior that increases risks to firefighters and developments and the likelihood of wildfires moving off NFS lands to private lands (or vice versa). As a result, taking no action would not meet Purpose and Need #6.

Resource Indicator: Fire behavior along FS Roads 43 and 4340
The result of taking no action to reduce fire hazards along FSR 43 and 4340 would be adverse, long-term, minor to moderate impacts because hazards would continue to increase along more of these roads as surface fuels accumulated, continued growth of vegetation created more ladder fuels to initiate crown fire, and surface fires included high flame lengths that increase fire intensity. These effects would restrict the use of these roads for ingress/egress, limit their usefulness as fuelbreaks during a wildfire, and curtail the use of direct suppression strategies with personnel and equipment. As a result, taking no action would not meet Purpose and Need #6.

Resource Indicator: FS Roads greater than 0.5 miles
Keeping roads in their current state would create beneficial, long-term, moderate impacts to access for vegetation and fire management. If roads are kept in their current state, open road access to several ridges and mid-slope forested stands would provide more options to continue using a wider variety of tools for forest management and allowing for more rapid access with equipment and personnel during fire suppression efforts. Roads that are currently closed would be remain on the landscape for use during future land management activities, and could be re-opened quickly to provide emergency fire suppression access. Open and closed roads would be available for use as escape routes. Although this results in more favorable access for vegetation and fire management resources than taking actions to close or decommissioning roads, taking no action would not meet Purpose and Need #7 because keeping all roads as they are in the project area does not provide for a road system that can be maintained to current standards.

3.6.4.3 Alternatives 2 and 3: Direct and Indirect Effects Common to Both Action Alternatives or to Alternative 2 Only

Proposed thinning and prescribed fire treatments that affect the amount and arrangement of CFR in Buttermilk Creek or Libby Creek, fire hazards in WUI, or fire hazards along FSR 43 or FSR 4340 are identical in Alternatives 2 and 3. Thinning and prescribed fire methods and prescriptions are described in Appendix A, including maintenance burning that would help maintain low levels of surface fuels and reduce small-diameter understory vegetation. The effects of these proposed treatments for both alternatives will be described in this section. With regards to proposed transportation changes, this section will only describe the effects of the Alternative 2 proposed transportation changes on access for vegetation and fire management.

3.6.4.3.1 Effects

The effects common to both action alternatives or to Alternative 2 only are displayed in **Figure 59**.

Figure 59. Fire/Fuels Resource Indicators and Measures Common to Alternatives 2 and 3 or unique to Alternative 2 Only

Resource Element	Resource Indicator	Measure	Alternatives 2 and 3
Restoration or maintenance of fire behavior to within the desired range of variability.	The amount and arrangement of each type of crown fire risk in the Buttermilk Creek and Libby Creek watershed as compared to the desired range of variability.	Percentage of landscape in Low, Moderate, & High risk of crown fire	**LOW CFR** Buttermilk = 39% Increased 7% towards desired range of 45-67% Libby = 65% Increased 12%, remains within desired range of 41-67%
			MODERATE CFR: Buttermilk = 23% Decreased 4%, still within desired range of 20-30% Libby = 21% Decreased 11%, remains within desired range of 20-36%
			HIGH CFR: Buttermilk = 38% Decreased 3% towards desired range of 12-28% Libby = 14% Decreased 2%, remains within desired range of 5-24%
		Average patch size in Low, Moderate, and High risk of crown fire	**LOW CFR** Buttermilk = 299 ac Increased 92 ac towards desired range of 1651-3714 ac Libby = 825 ac Increased 425 ac, now within desired range of 713-3714 ac

Resource Element	Resource Indicator	Measure	Alternatives 2 and 3
			MODERATE CFR: Buttermilk = 237 ac Decreased 68 ac away from desired range of 460-2073 ac Libby = 170 ac Decreased 98 ac away from desired range of 460-1776 ac
			HIGH CFR: Buttermilk = 1734 ac Increased 230 ac, remains within desired range of 523-2125 ac Libby = 264 ac Increased 16 ac, remains within desired range of 242-934 ac
Wildfire hazard in Wildland Urban Interface	Fire behavior in WUI (22,890 acres total)	Percent of flame length by size class	Low: 57% Moderate: 32% High: 3% Extreme: 8%
		Percent of fire behavior by type	None: 3% Surface: 88% Crown: 9%
	Fire behavior along FS Roads 43 and 4340 (701 acres total)	Percent of flame length by size class	Low: 92% Moderate: 6% High: 1% Extreme: 1%
		Percent of fire behavior by type	None: 28% Surface: 69% Crown: 3%
Alternative 2 Only			
Access for vegetation and fire management	FS Roads in project area > 0.5 miles (99.3 miles total)	Percent of FS roads greater than ½ mile in length that would remain or be decommissioned.	Remain: 89% Decommissioned: 11%

Resource Indicator: The amount and arrangement of each type of crown fire risk in the Buttermilk Creek watershed as compared to the desired range of variability.
Post-treatment changes in CFR in the Buttermilk and Libby Creek drainages is shown in **Figure 60** below.

While fire behavior is strongly influenced by climate and topography, these factors cannot be easily altered by treatments; therefore the treatments proposed in this project to address any aspect of wildfire behavior focus on altering the amount and arrangement of surface fuels and standing vegetation. The combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, long-term, minor effect in re-establishing the desired amount and arrangement of low CFR because these areas are not widespread across the drainage. The combination of understory thinning and prescribed fire (without overstory thinning) would create beneficial, short-term, moderate effects on re-establishing the desired amount and arrangement of low CFR because they affect more areas within the drainage. Proposed management actions including thinning and prescribed fire treatments would increase the amount of low CFR in the Buttermilk drainage, although the amount would remain below desired range after project implementation was complete. The average patch size of areas with low CFR would increase slightly but remain well below the desired range. Additional management actions would be needed to continue to increase the area and average patch size with low CFR after this project is completed. The combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, long-term, minor effect in re-establishing the desired amount and arrangement of low CFR because these areas are not widespread across the drainage. The combination of understory thinning and prescribed fire (without overstory thinning) would create beneficial, short-term, moderate effects on re-establishing the desired amount and arrangement of low CFR because they affect more areas within the drainage. Where underburning is proposed, the initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would reduce surface fuel loading, scorch lower tree branches, and help maintain the open arrangement of understory trees to limit the potential for crown fire initiation. This would create a beneficial, long-term, minor to moderate effect by extending the impact of the first treatments. Management actions like thinning and prescribed fire treatments are viable fire surrogates that would help restore desired fire behavior and effects (USDA 2012b; Agee and Skinner 2005; Covington 2003; Prichard et al. 2010; Stephens et al. 2012). The effects of proposed treatments would include:

1. Increasing canopy base heights by thinning units by thinning and pruning small-diameter understory trees up to approximately 8 inches diameter at breast height (DBH) to reduce ladder fuels that provide a path for fire to move from the surface to the overstory tree canopy, or though the overstory. This treatment would mimic understory tree mortality and lower branch removal caused by wildfires (Peterson et al. 2005).
2. Reducing overstory canopy bulk density and canopy continuity in overstory thinning units by removing trees averaging 10 inches DBH and 20 feet tall.

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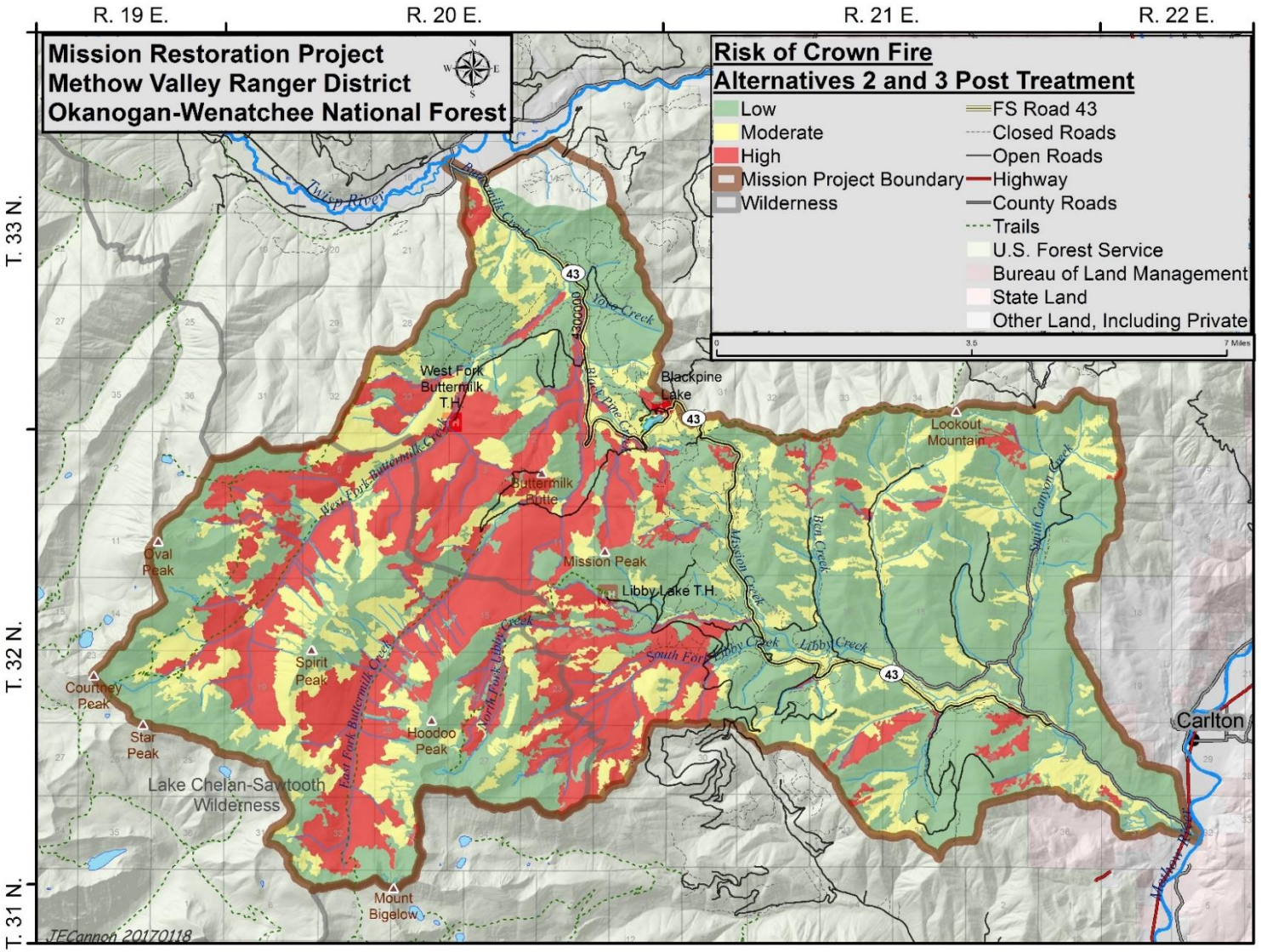
Figure 60. Post-treatment risk of crown fire in project area.


R. 19 E.
R. 20 E.
R. 21 E.
R. 22 E.
T. 33 N.
T. 32 N.
T. 31 N.
Mission Restoration Project
Methow Valley Ranger District
Okanogan-Wenatchee National Forest
Risk of Crown Fire
Alternatives 2 and 3 Post Treatment
Low
Moderate
High
Mission Project Boundary
Wilderness
FS Road 43
Closed Roads
Open Roads
Highway
County Roads
Trails
U.S. Forest Service
Bureau of Land Management
State Land
Other Land, Including Private
0
3.5
7 Miles
Twisp River
Buttermilk Creek
Boyds Creek
Black Pine Creek
West Fork Buttermilk Creek
West Fork Buttermilk T.H.
Blackpine Lake
Lookout Mountain
Buttermilk Butte
Oval Peak
Mission Peak
Libby Lake T.H.
Mission Creek
Ben Creek
South Canyon Creek
Spirit Peak
Courtney Peak
Star Peak
East Fork Buttermilk Creek
North Fork Libby Creek
South Fork Libby Creek
Libby Creek
Hoodoo Peak
Lake Chelan-Sawtooth Wilderness
Carlton
Methow River
Mount Bigelow
JECannon 20170118

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3. Reducing surface fuels in thinning units through a combination of piling and pile burning, and underburning. In units where debris was piled, surface fuel reduction would generally be limited to the footprint of the piles.

In addition to these effects, treatments would create a more open landscape where understory herbaceous vegetation would eventually grow, contributing to fuel loading and possibly increasing fire spread rates. The flame lengths created by these fuels, however, would still be less than those created by torching trees, the fire behavior more likely without thinning. In opening up the overstory and understory, thinning may contribute to an increase in surface wind speeds by reducing stand density that would have helped limit the influence of winds on fire behavior. Thinning would also allow wind and sunlight to dry out surface fuels (Agee and Skinner 2005). These concerns, however, are countered by the advantages of fire-resilient forests described in Agee and Skinner (ibid).

Figure 61. Principles of Fire-Resilient Forests

Principle	Effect	Advantage
Reduce surface fuel	Reduce potential flame length	Easier control, less torching/spotting
Increase canopy base height	Requires longer flame length to begin torching	Less torching/spotting
Decrease crown density	Decreases probability of tree-to-tree crown fire	Reduces crown fire potential
Retain larger trees	Remaining trees have thicker bark and taller crowns	Increases survivability of trees

In areas with moderate CFR, the combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, long-term, minor effect in maintaining the desired amount of moderate CFR because these treatments increase resilience to wildfires a described above over limited areas of moderate CFR. The combination of understory thinning and prescribed fire (without overstory thinning) would create beneficial, short-term, moderate effects on maintaining the desired amount of moderate CFR because they affect more areas within the drainage. The amount of moderate CFR in the Buttermilk Creek drainage would decrease as some of these areas would be treated to increase the area and average patch size of low CFR, but the overall amount of moderate CFR would remain within the desired range. The initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would reduce surface fuel loading, scorch lower tree branches, and help maintain the open arrangement of understory trees to limit the potential for crown fire initiation. The average patch size of areas with moderate CFR would move further from the desired range because these areas would be treated in some locations to create larger patches of low CFR. The remaining smaller patches of moderate CFR would be likely to have fire behavior related to low CFR (low fire severity, low mortality rates) infiltrate the smaller remaining patches of moderate CFR. Post-fire, the rapid rate of recovery from adjacent areas of low CFR would likely affect that of areas with moderate CFR. This type of fire behavior and recovery would increase resilience to wildfire in smaller patches of moderate CFR and is within the range of low-to-high severity fire behavior common to these areas.

The combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, short-term, minor effect in moving toward the desired amount of high CFR because these treatments affect small areas of high CFR in limited areas of the drainage. The amount of high CFR in this drainage would decrease post-treatment to create areas of low CFR, but remain above the desired range, indicating that more treatments would be needed in the future to reduce the amount of high CFR in this drainage. The average patch size of areas with high CFR would increase, but remain within the desired range. The amount and arrangement of high CFR would remain largely unaffected where it existed historically in the upland areas in the southern portion of this drainage. These areas are within a designated wilderness or inventoried roadless area (IRA) with none to very limited options for active management to reduce CFR; these areas will likely remain unchanged till affected by wildfire. Some areas of high CFR lie outside in the lower portion of the drainage, outside of a wilderness or IRA, but have limited to no road access to provide for safe conditions for personnel during prescribed fire activities.

Resource Indicator: The amount and arrangement of each type of crown fire risk in the Libby Creek watershed as compared to the desired range of variability.
The combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, long-term, minor to moderate effect in maintaining or re-establishing the desired amount and arrangement of low CFR because the arrangement of treated areas would help create more continuous patches of low CFR. The combination of understory thinning and prescribed fire (without overstory thinning) would create beneficial, short-term, moderate effects on re-establishing the desired amount and arrangement of low CFR because they affect more areas within the drainage. The amount of low CFR in the Libby Creek drainage would increase and remain within the desired range after project implementation was complete. The average patch size of areas with low CFR would increase to within the desired range. The initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would reduce surface fuel loading, scorch lower tree branches, and help maintain the open arrangement of understory trees to limit the potential for crown fire initiation. The effects of proposed treatments would include those listed in **Figure 59** above.

In areas with moderate CFR, the combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, long-term, minor effect in maintaining the desired amount of moderate CFR because these treatments increase resilience to wildfires a described above over limited areas of moderate CFR. The combination of understory thinning and prescribed fire (without overstory thinning) would create beneficial, short-term, moderate effects on maintaining the desired amount of moderate CFR because they affect more areas within the drainage. The amount of moderate CFR in the Libby Creek drainage would decrease as some of these areas would be treated to increase the area and average patch size of low CFR, but the overall amount of moderate CFR would remain within the desired range. The initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would reduce surface fuel loading, scorch lower tree branches, and help maintain the open arrangement of understory trees to limit the potential for crown fire initiation. The average patch size of areas with moderate CFR would move further from the desired range because these areas would be treated in some locations to create larger

patches of low CFR. The remaining smaller patches of moderate CFR would be likely to have fire behavior related to low CFR (low fire severity, low mortality rates) infiltrate the smaller remaining patches of moderate CFR. Post-fire, the rapid rate of recovery from adjacent areas of low CFR would likely affect that of areas with moderate CFR. This type of fire behavior and recovery would increase resilience to wildfire in smaller patches of moderate CFR and is within the range of low-to-high severity fire behavior common to these areas.

The combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, short-term, minor effect in maintaining the desired amount of high CFR because these treatments keep this risk level from increasing in undesirable areas such as adjacent to WUI in the drainage. The amount of high CFR in this drainage would decrease post-treatment to create areas of low CFR and remains within the desired range. The average patch size of areas with high CFR would increase, but remain within the desired range. The amount and arrangement of high CFR would remain largely unaffected where it existed historically in the upland areas in west-southwestern portions of this drainage. These areas are within a designated wilderness or inventoried roadless area (IRA) with none to very limited options for active management to alter high CFR; these areas will likely remain unchanged till affected by wildfire.

Resource Indicator: Fire behavior in WUI

Proposed treatments in WUI would create beneficial, short-term, minor to moderate effects by reducing flame lengths and limiting crown fire behavior because proposed thinning and prescribed fire treatments would have the impacts described in **Figure 59** above. Under modeled conditions, the amount of area with low flame lengths would increase by 5%, the amount with moderate flame lengths would decrease by 3%, and areas with high or extreme flame lengths would decrease by 1% each. The amount of area with surface fire would increase by 6%. Reducing fire behavior in the WUI would increase the likelihood of successful direct suppression tactics by creating lower fire intensities that accompany reduced flame length and more limited crown fire behavior. Spotting potential would diminish because torching would be more limited. A reduction in flame lengths and crown fire behavior would help create a safer environment for firefighters and developments. Treatments would create a more open landscape where understory herbaceous vegetation would eventually grow, contributing to fuel loading. The flame lengths created by these fuels, however, would still be less than those created by torching trees. Openings in the tree canopy would allow for more successful use of retardant to limit fire spread. Where underburning is proposed, the initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would maintain lower surface fuel loading, scorch lower tree branches, and help sustain the open arrangement of understory trees to limit the potential for crown fire initiation. This would create a beneficial, long-term, minor to moderate effect by extending the impact of the first treatments. **Figure 62** shows post-treatment fire behavior in the WUI under modeled conditions.

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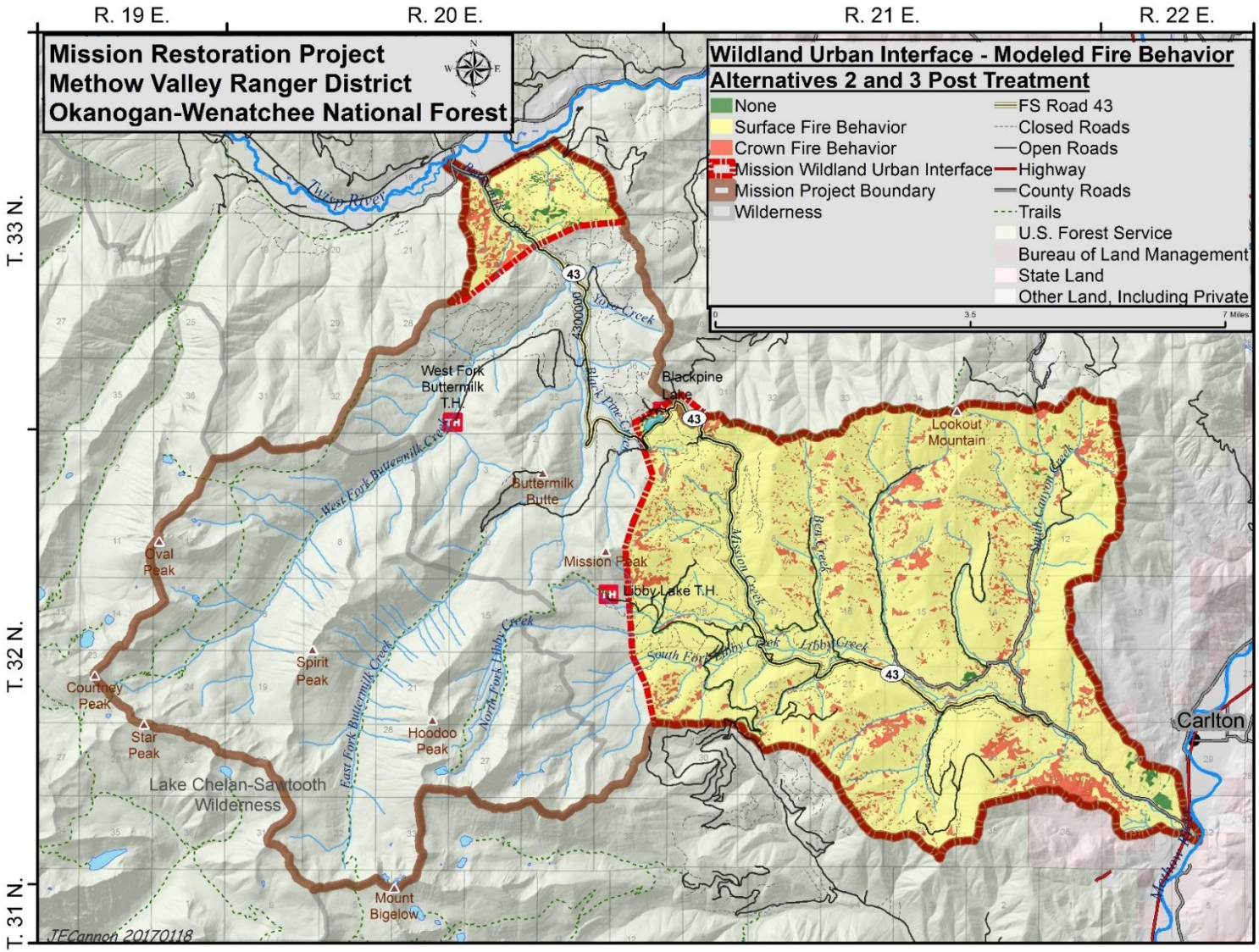
Figure 62. Post-treatment modeled fire behavior in the Wildland Urban Interface (WUI).


R. 19 E.
R. 20 E.
R. 21 E.
R. 22 E.
T. 33 N.
T. 32 N.
T. 31 N.
Mission Restoration Project
Methow Valley Ranger District
Okanogan-Wenatchee National Forest
Wildland Urban Interface - Modeled Fire Behavior
Alternatives 2 and 3 Post Treatment
None
Surface Fire Behavior
Crown Fire Behavior
Mission Wildland Urban Interface
Mission Project Boundary
Wilderness
FS Road 43
Closed Roads
Open Roads
Highway
County Roads
Trails
U.S. Forest Service
Bureau of Land Management
State Land
Other Land, Including Private
0
3.5
7 Miles
Twisp River
Poorman Creek
Towe Creek
4300000
Black Pine Creek
West Fork Buttermilk T.H.
West Fork Buttermilk Creek
Blackpine Lake
Lookout Mountain
Buttermilk Butte
Oval Peak
Mission Peak
Libby Lake T.H.
Mission Creek
Ben Creek
South Fork Libby Creek
Libby Creek
South Fork Buttermilk Creek
North Fork Libby Creek
Spirit Peak
Courtney Peak
Star Peak
Hoodoo Peak
Lake Chelan-Sawtooth Wilderness
East Fork Buttermilk Creek
Mount Bigelow
Carlton
JECannon 20170118

Note to reader: Page references provided in the Notice of Opportunity to Comment for the Mission Revised Preliminary EA may be off by one number in this excerpt from the full document.

Resource Indicator: Fire hazards along FS Roads 43 and 4340

Proposed treatments along FS Roads 43 and 4340 would create beneficial, short-term, minor to moderate effects by reducing flame lengths and limiting crown fire behavior because proposed thinning and prescribed fire treatments would have the impacts described in **Figure 59** above. Under modeled conditions, the amount of area with low flame lengths would increase by 7%, the amount with moderate flame lengths would decrease by 3%, the amount of area with high flame lengths would decrease by 1%, and extreme flame lengths would decrease in 3% of the area. The amount of area with surface fire would increase by 8%. Reducing fire behavior along these roads would increase the safety of those using them for ingress and egress, and provide for more successful direct suppression tactics by creating lower fire intensities that accompany reduced flame length and more limited crown fire behavior. Spotting potential would diminish because torching would be more limited. A reduction in flame lengths and crown fire behavior would help create a safer environment for firefighters and developments. Treatments would create a more open landscape where understory herbaceous vegetation would eventually grow and contribute to fuel loading and increased flame lengths. The flame lengths created by these fuels, however, would still be less than those created by torching trees. Openings in the tree canopy would allow for more successful use of retardant to limit fire spread. Where underburning is proposed, the initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would maintain lower surface fuel loading, scorch lower tree branches, and help sustain the open arrangement of understory trees to limit the potential for crown fire initiation. These treatments would help create a fuelbreak with beneficial, long-term, minor to moderate effects by extending the impact of the first treatments. WUI treatments adjacent to private lands would be prioritized as funding became available. The effectiveness of these treatments would last approximately 10-15 years until surface fuels and vegetation accumulated enough to counteract the changes brought about by proposed treatments. At that time, further thinning and/or prescribed fire treatments would be necessary to extend the effectiveness of these fuelbreaks.

Resource Indicator: FS Roads greater than 0.5 miles

Alternative 2 would have 11% fewer miles of roads greater than 0.5 miles on NFS lands than Alternative 1, resulting in adverse, long-term, minor impacts to access for vegetation and fire management. Most of the changes in road status between Alternatives 1 and 2 would be from open to closed, allowing for their continued use during emergency fire suppression or longer-range vegetation and fuels management activities. Decommissioning would occur on roads that access areas that are generally accessible from other roads, or on roads that access areas with limited forest management needs.

3.6.4.3.2 Cumulative Effects

Spatial and Temporal Context for Effects Analysis

The spatial boundary for analyzing the cumulative effects to the fire and fuels resource is the project area boundary because it follows the natural geographical border of sub-watersheds that form the boundary of the area assessed for departure from the desired range of CFR. Wildfires within this area are the most likely to affect WUI and the use of FS Roads 43 and 4340. Roads within this area provide the only access to the project area for vegetation and fuels management and fire suppression.

The temporal boundary for analyzing the cumulative effects to amount and arrangement of CFR and wildfire hazards in WUI is 15 years post-project because after this point, surface fuels and understory vegetation changed by proposed treatments would accumulate to the point of contributing to increased CFR and wildfire hazards. Overstory thinning would have a longer effect on crown fire behavior (up to 30-50 years) depending on the length of time it took for understory trees to grow into the overstory; however, this time period will not be used as temporal boundary because surface fuels and understory vegetation changes that would affect fire behavior would occur 15 to 35 years before this period. The temporal boundary for analyzing the cumulative effects to access for vegetation and fuels management is 30 years, the likely period of time until future management activities would occur after all treatments proposed in this project are completed.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis
The cumulative effects of past management actions before 2011 on CFR have already been evaluated in this analysis because EMDS considered the type and arrangement of vegetation, surface fuel, species composition, stand structure, and other characteristics created by past thinning, prescribed burning, insect & disease outbreaks, wildfires, and grazing. Effects of wildfires in the project area have been considered in WUI hazard analysis by adjusting fuel models to account for changes when determining existing fire behavior. Past actions to close or decommission roads have helped create the existing condition. For these reasons, the analysis of past actions in this section is based on current environmental conditions.

There are no present or reasonably foreseeable actions within the spatial or temporal context for this effects analysis that would affect the amount or arrangement of crown fire risk, change fire behavior in WUI or along FS Roads 43 and 4340, or alter road access for vegetation and fire management. Some private landowners in the Libby Creek watershed may intend to reduce hazardous fuels around their homes to minimize wildfire hazards in WUI, but the location and timing of these plans are known. Considering the impacts of the proposed actions again in a cumulative effects analysis would repeat the existing condition analysis described above. Therefore, there are no cumulative effects to this resource element in Alternative 2.

3.6.4.3.3 Summary of Effects
Implementing the proposed thinning and prescribed fire treatments described above would cause beneficial, short term to long term, minor to moderate effects on maintaining or moving toward the desired range of crown fire behavior in the Buttermilk and Libby sub-watersheds. These treatments would cause beneficial, short-term, minor to moderate effects on reducing fire behavior in WUI and wildfire risks along FS Roads 43 and 4340. Alternative 2 would implement proposed changes in transportation access that would cause adverse, long term, minor impacts to road access for vegetation and fire management.

3.6.4.4 Alternative 3
Because the proposed thinning and prescribed fire treatments described for Alternative 2 are identical in Alternative 3, this section will only describe the effects of the Alternative 3 proposed transportation changes on access for vegetation and fire management.

3.6.4.4.1 Effects

The only fire/fuels resource indicator that is different in Alternative 3 is displayed in **Figure 63**.

Figure 63. Fire/Fuels Resource Indicator and Measure for Alternative 3

Resource Element	Resource Indicator	Measure	Alternative 3
Access for vegetation and fire management	FS Roads in project area > 0.5 miles (99.3 miles total)	Percent of FS roads >0.5 miles long that would remain or be decommissioned post-project.	Remain: 69% Decommissioned: 30%

Resource Indicator: Roads in project area

Alternative 3 would have 31% fewer miles of remaining roads that are greater than 0.5 miles than Alternative 1, resulting in adverse, long-term, moderate impacts to access for vegetation and fire management. Alternative 3 would have three times the amount of decommissioning compared to Alternative 2. The greatest impacts for vegetation and fire management would be approximately 2645 acres in areas accessed by the roads listed in **Figure 64** below. Those noted as within "Designated WUI" lie within the CWPP WUI boundary in areas identified as areas with high risk to private lands. The loss of roads in these areas would limit the options available for vegetation management because, although roads could theoretically be built into these areas again in the future, it is highly unlikely that the amount of current roaded access would be recreated. Current limitations on the harvest technology and uneconomical alternatives such as helicopter or cable logging would further restrict opportunities to conduct treatments such as overstory thinning in future projects. Understory thinning and prescribed fire treatments may still occur in the future, but limited access would increase implementation costs and would increase safety hazards for personnel working in these areas. Fire suppression access in the areas listed below would require longer access times with more limited resources (in the case of ground-based resources) or would be more dependent on aerially delivered firefighters.

Figure 64. Road Systems Proposed for Decommissioning in Alternative 3

FS Road System	Area Accessed	Designated WUI
4300145 4300146 4300150-1.22L-1	Hornet Ridge	Y
4300220	Forest south of Blackpine Meadows	N
4300550 4300553 4300555 4300556 4300560	West of West Fork Buttermilk Creek, Scaffold Ridge	N

4300615	Yoyo Creek/Shady Nook basin	N
4300645	Yoyo Creek/Shady Nook basin	N
4340700 4340785 4340788	West of Mission Creek	Y
4342300	Chicamun Canyon	Y

3.6.4.4.2 Cumulative Effects

There would be no impacts from cumulative effects for Alternative 3. Further information on potential cumulative effects are described as part of the Alternative 2 section.

3.6.4.4.3 Summary of Effects

Implementing proposed transportation system changes in this alternative would cause adverse, long-term, moderate impacts to access for vegetation and fire management.

3.6.4.5 Summary of Effects

If no action were taken in this project, restoration of desired ranges of CFR would experience adverse, long-term, minor to major impacts. Fire behavior in WUI and fire hazards along FS Roads 43 and 4340 would experience adverse, short-term to long-term, minor to moderate impacts. Road access for vegetation and fire management would experience beneficial, long-term, moderate impacts.

In either action alternative, proposed thinning and prescribed fire treatments would cause beneficial, short term to long term, minor to moderate effects on maintaining or moving toward the desired range of crown fire behavior in the Buttermilk and Libby sub-watersheds. These treatments would cause beneficial, short-term, minor to moderate effects on reducing fire behavior in WUI and wildfire risks along FS Roads 43 and 4340. Alternative 2 would implement proposed changes in transportation access that would cause adverse, long term, minor impacts to road access for vegetation and fire management. Alternative 3 would implement proposed changes in transportation access that would cause adverse, long term, moderate impacts to road access for vegetation and fire management.

Figure 65. Summary of existing condition and effects for the proposed alternatives.

Resource Indicator	Measure	Existing Condition (Alternative 1)	Alternative 2	Alternative 3
The amount and arrangement of each type of crown fire risk in the Buttermilk Creek and Libby Creek watershed as compared to the desired range of variability.	Percentage of landscape in Low, Moderate, & High risk of crown fire	**LOW CFR:** Buttermilk = 32% Below desired range of 45-67% Libby = 53% Within desired range of 41-67%	**LOW CFR** Buttermilk = 39% Increased 7% towards desired range of 45-67% Libby = 65% Increased 12%, remains within desired range of 41-67%	**LOW CFR** Buttermilk = 39% Increased 7% towards desired range of 45-67% Libby = 65% Increased 12%, remains within desired range of 41-67%
		MODERATE CFR: Buttermilk = 27% Within desired range of 20-30% Libby = 32% Within desired range of 20-36%	**MODERATE CFR:** Buttermilk = 23% Decreased 4%, still within desired range of 20-30% Libby = 21% Decreased 11%, remains within desired range of 20-36%	**MODERATE CFR:** Buttermilk = 23% Decreased 4%, still within desired range of 20-30% Libby = 21% Decreased 11%, remains within desired range of 20-36%
		HIGH CFR: Buttermilk = 41% Above desired range of 12-28% Libby = 16% Within desired range of 5-24%	**HIGH CFR:** Buttermilk = 38% Decreased 3% towards desired range of 12-28% Libby = 14% Decreased 2%, remains within desired range of 5-24%	**HIGH CFR:** Buttermilk = 38% Decreased 3% towards desired range of 12-28% Libby = 14% Decreased 2%, remains within desired range of 5-24%

Resource Indicator	Measure	Existing Condition (Alternative 1)	Alternative 2	Alternative 3
	Average patch size in Low, Moderate, and High risk of crown fire	**LOW CFR:** Buttermilk = 207 ac Below desired range of 1651-3714 ac Libby = 400 ac Below desired range of 713-3714 ac	**LOW CFR** Buttermilk = 299 ac Increased 92 ac towards desired range of 1651-3714 ac Libby = 825 ac Increased 425 ac, now within desired range of 713-3714 ac	**LOW CFR** Buttermilk = 299 ac Increased 92 ac towards desired range of 1651-3714 ac Libby = 825 ac Increased 425 ac, now within desired range of 713-3714 ac
		MODERATE CFR: Buttermilk = 305 ac Below desired range of 460-2073 ac Libby = 268 ac Below desired range of 460-1776 ac	**MODERATE CFR:** Buttermilk = 237 ac Decreased 68 ac away from desired range of 460-2073 ac Libby = 170 ac Decreased 98 ac away from desired range of 460-1776 ac	**MODERATE CFR:** Buttermilk = 237 ac Decreased 68 ac away from desired range of 460-2073 ac Libby = 170 ac Decreased 98 ac away from desired range of 460-1776 ac
		HIGH CFR: Buttermilk = 1504 ac Within desired range of 523-2125 ac Libby = 248 ac Within desired range of 242-934 ac	**HIGH CFR:** Buttermilk = 1734 ac Increased 230 ac, remains within desired range of 523-2125 ac Libby = 264 ac Increased 16 ac, remains within desired range of 242-934 ac	**HIGH CFR:** Buttermilk = 1734 ac Increased 230 ac, remains within desired range of 523-2125 ac Libby = 264 ac Increased 16 ac, remains within desired range of 242-934 ac
Fire behavior in WUI (23,000 acres total)	Percent of flame length by size class Percent of fire behavior by type	Low: 52% Moderate:35% High: 4% Extreme: 9% None: 3% Surface: 82% Crown: 15%	Low: 57% Moderate: 32% High: 3% Extreme: 8% None: 3% Surface: 88% Crown: 9%	Low: 57% Moderate: 32% High: 3% Extreme: 8% None: 3% Surface: 88% Crown: 9%

Resource Indicator	Measure	Existing Condition (Alternative 1)	Alternative 2	Alternative 3
Fire behavior along FS Roads 43 and 4340 (701 acres total)	Percent of flame length by size class	Low: 85% Moderate: 9% High: 2% Extreme: 4%	Low: 92% Moderate: 6% High: 1% Extreme: 1%	Low: 92% Moderate: 6% High: 1% Extreme: 1%
	Percent of fire behavior by type	None: 28% Surface: 61% Crown: 11%	None: 28% Surface: 69% Crown: 3%	None: 28% Surface: 69% Crown: 3%
FS Roads in project area.> 0.5 miles (99.3 miles total)	Percent of FS roads greater than ½ mile in length that would remain or be decommissioned.	Remain: 100% Decommissioned: 0%	Remain: 89% Decommissioned: 11%	Remain: 69% Decommissioned: 30%

3.6.5 Consistency Statement

Okanogan National Forest Land and Resource Management Plan

Implementing the proposed action would be consistent with the goals, objectives, and standards and guidelines of the Forest Plan as follows:

Forest-wide Standards and Guidelines:

- 19-4: Prescribed fire would be used to meet Management Area goals.
- 19-6: Fuels treatments would be designed to be cost-effective and consider fuel profiles, site-productivity, and other relevant objectives. Desired fuel profiles and treatments necessary to achieve this profile have been determined. Treatment methods have been selected based on analysis of long-term site-productivity considerations.
- 19-7: Fuels treatments would help provide for retention or, in some areas, increase of large woody debris on the forest floor.
- 19-8: Treatment of natural fuels would not occur in old growth stands meeting the criteria for Forest Plan Old Growth.
- 19-9: Fuels treatments in stands managed as future old growth would provide for retention of key old growth components.
- 20-1: site-preparation objectives would occur concurrently with fuels management objectives.
- 20-26: Firewood availability would be considered in site preparation planning.
- 20-49: Fuels treatments after precommercial and commercial thinning would minimize damage to residual stems. Post-treatment tree retention levels would be prescribed in fuels treatments.

Management Area 5 (Roaded Natural Recreation and Scenic Viewing, Retention or Partial Retention):

- MA 5-19C: Prescribed fire would meet the visual quality objective within three years of application.
- MA5-19C: Fuels treatment methods and locations would consider recreation, visual, and wildlife values.

Management Area 14 (Deer Winter Range – Wood Fiber Production):

- MA 14-19C: Fuels would be treated to reduce the risk of wildfire to acceptable levels and further protect timber stands, wildlife values, and other resources from unacceptable losses caused by wildfire.
- MA14-19D: Where cost-effective, fire-tolerant stands would be on a prescribed burning schedule.

Management Area 15B (unmodified primitive environment within designated wilderness):

- MA 15B-19C: Planned ignitions are not proposed in wilderness.
- MA15B-19D: Prescribed fire is not proposed in wilderness.
- MA15B-19E: Prescribed fire is not proposed in wilderness.

Management Area 17 (Developed Recreation Opportunities):

- MA17-19C: Fuels treatments would incorporate visual and recreation objectives and be designed to reduce or eliminate damaging wildfire effects to recreation resources.

Management Area 25 (Intensive Timber and Range Management):

- MA25-19C: Fuels treatments would reduce risk of wildfire to acceptable levels while maintaining long-term site productivity.
- MA25-19D: Fuels would be treated to reduce the risk of wildfire to acceptable levels and further protect timber stands, wildlife values, and other resources from unacceptable losses caused by wildfire.
- MA25-19E: Where cost-effective, fire-tolerant stands would be on a prescribed burning schedule.

Management Area 26 (Deer Winter Range, Modified Recreation):

- MA26-19C: Fuels treatments would provide for the retention and/or enhancement of key wildlife habitat wherever practicable by increasing forage available for deer and by reducing the risk of widespread loss of habitat from uncharacteristic wildfire behavior.

Forest Plan Amendment Effects on Substantive Provisions

To meet Purpose and Needs #2, #3, #4 and #6 identified in Chapter 1 of the EA, vegetation management through thinning would reduce deer winter range cover below Okanogan National Forest Land Resource Management Plan Standard and Guidelines MA14-6A and MA26-6A, requiring a project-specific amendment. The 2012 Planning Rule as amended (36 CFR 219) requires consideration of how such an amendment would affect substantive provisions identified in the Planning Rule. With respect to air quality, the following substantive provisions would be affected by the proposed amendment:

219.8(a)(1)(iv) System drivers such as wildland fire. Thinning and associated prescribed fire treatments on 746 acres as provided by the amendment would have a beneficial, short- to long-term, minor to moderate effect on wildland fire behavior because they would reduce surface fuels and understory stand density in dry forested areas, lessening the likelihood of

uncharacteristic widespread crown fire initiation. Where overstory thinning occurred, as a result of this amendment, the duration of this effect would be extended further than where understory thinning alone occurred, and would also reduce the risk of crown-to-crown fire because thinning would decrease crown density. This type of fire behavior is similar to the type of wildland fire that occurred historically in dry forest types (primarily low-intensity fires with limited crown fire behavior) (USDA 2012b; Agee and Skinner 2005; Prichard et al. 2010).

219.8(b)(1) Social, cultural and economic considerations. Thinning as provided by this amendment would have a beneficial, short-term, minor to moderate effect on social conditions because of how it would affect fire behavior in the WUI. Deer winter cover overlaps with most of the WUI in the project area, and thinning treatments that would reduce cover below S&Gs overlaps up to 3% of the WUI. Thinning and associated prescribed burning treatments as allowed by this amendment would reduce surface fuel loads, increase canopy base height, and, where commercial thinning occurred, decrease crown density in the overstory. The combined effect of these changes would be a reduction in potential surface flame lengths with easier control; a reduction in the chance for crown-fire initiation and therefore less fire growth through torching and spotting; and a reduction in the probability of tree-to-tree crown fire (USDA 2012b; Agee and Skinner 2005; Prichard et al. 2010). Thinning treatments would create a more open landscape where understory herbaceous vegetation would eventually grow, contributing to fuel loading. The flame lengths created by these fuels, however, would be less than those created by torching trees that is currently more likely. Openings in the tree canopy would allow for more successful use of retardant to limit fire spread. By reducing wildfire risks near private lands and increasing the likelihood of successful suppression actions in the WUI, thinning as a result of this amendment would help increase sustainability of local communities in the WUI.

Northwest Forest Plan

Riparian Reserves:

- FM-1: Fuels treatments would help attain Riparian Management Objectives by increasing the resilience of RRs to disturbance by wildfire while minimizing disturbance of riparian ground cover and vegetation. Treatment strategies have been developed with recognition of the role of fire in ecosystem function and identify instances where fuels management activities could damage long-term ecosystem function.
- FM-4: Prescribed burn projects and prescriptions would be designed to contribute to attainment of Aquatic Conservation Strategy objectives.
- FM-5: If Riparian Reserves are significantly damaged by prescribed burning outside prescribed parameters, a review by district aquatic, soil, and/or hydrology staff would occur to determine whether adverse effects occurred and what, if any, rehabilitation treatment would be needed to attain Aquatic Conservation Strategy objectives, and what that treatment plan would entail.
- Other: In Riparian Reserves, water drafting sites would be located and managed to minimize adverse effects on riparian habitat and water quality, as consistent with Aquatic Conservation Strategy objectives.

Late-Successional Reserves:

- Fuels management in LSRs will use minimum impact suppression methods in accordance with guidelines for reducing risks of large-scale disturbances.

Matrix:

- Fuels management activities were developed based on input from local governments, agencies, and landowners as well as input from watershed analyses and considered factors that may affect hazard reduction goals.

Forest Service Manual Direction

FSM 5103.2 Ecological: This project identified and used fire ecology to frame land and resource management objectives. Fire Management programs and activities would be used to implement LRMP objectives. Public health and environmental quality considerations have been factored into proposed activities. Proposed treatments would provide for a landscape that is more resilient to disturbance in accordance with management objectives

FSM 5140.3 Policy: Proposed treatments would implement a hazardous fuels management and prescribed fire program applying principles and policy elements to restore resilient landscapes described in FSM 5103 and Wildland Fire Doctrine (FSM 5131); principles from the Cohesive Strategy (A National Cohesive Wildland Fire Management Strategy Phase II National Report, May 2012) (Wildland Fire Leadership Council; 2012); and guidelines from the Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide (NWCG 2014).

FSM 5141 Hazardous Fuels Management and Prescribed Fire Planning: Proposed hazardous fuels management and prescribed fire treatments have been developed in compliance with the LRMP to meet resource management objectives. Resource objectives for specific hazardous fuels management and prescribed fire projects were derived from the NEPA analysis. The entire project area has been analyzed under NEPA. The NEPA analysis document identifies objectives and analyzes the effects of hazardous fuels management and prescribed fire projects.

FSM 5142.3 Prescribed Fire Policy: Proposed prescribed fire treatments would be used in a safe, carefully planned, and cost-effective manner to achieve desired conditions and attain management objectives identified in the LRMP. Prescribed fire plans, including wildfire declarations, will use the Interagency Prescribed Fire Planning and Implementation Procedures Guide. Weather conditions would be monitored during all phases (including mop-up) of prescribed fire implementation. Long-term weather conditions such as drought would be considered in all phases of prescribed fire planning and implementation. Unless the authorizing official makes an exemption, a project-specific spot weather forecast would be obtained prior to ignition; for each day that ignition continues; on any day the fire is actively spreading; or when conditions adversely affecting the prescribed fire are predicted in the general forecast.

Watershed Analyses

Recommendations from watershed analyses that have been considered in this project include considering landowners input in implementing prescribed fire in the watershed; proposing treatments in Libby Creek to minimize the potential for high-severity fires to degrade large areas and destroy habitat for threatened or endangered fish species; proposing treatments in Libby

Creek that utilize thinning, underburning, and mistletoe sanitation to maintain stand health and minimize potential for stand-replacing fires; and focusing proposed thinning and prescribed burning treatments in WUI to minimize the risk of fire spread between NFS and private lands, especially in Smith Canyon, Elderberry Canyon, Chicamun Canyon, and Lower Libby Creek.

Federal Wildland Fire Management Policy
This analysis recognizes wildland fire as an essential ecological process. Proposed activities focus on reducing hazardous fuels and restoring fire-adapted ecosystems and used planning and decision analysis processes that address current and anticipated conditions.

Okanogan-Wenatchee Forest Restoration Strategy
The Restoration Strategy was used to analyze conditions in the Mission project area and develop possible treatment options to respond to findings. Proposed treatments would maintain forested landscapes in the desired range, or help move them toward this range.

Spruce Budworm Assessment
Recommendations from this document that have been considered in this project include focusing silvicultural and prescribed fire treatments in the dry-cover types to reduce susceptibility to western spruce budworm and reduce risk of uncharacteristic crown fires; and implementing a fuelbreak and road treatment strategy to provide additional time for silvicultural and fuels treatments to occur.

Okanogan County Community Wildfire Protection Plan
This project proposes treatments to reduce wildfire risks in the WUI and specifically within the two CWPP priority treatment areas that lie within the project boundary.

National Roadmap for Responding to Climate Change
This analysis is consistent with the guidance for National Forests to adapt and prepare for changing climates, with a management emphasis on restoring the functions and processes characteristic of healthy, resilient ecosystems through adaptive restoration. Proposed restoration treatments in this project would also improve the ability of ecosystems to withstand the stresses and uncertainties associated with climate change. Proposed thinning treatments are aligned with those suggested to promote resistance, resilience, and response to climate change as synthesized in *Responding to Climate Change in National Forests: a Guidebook for Developing Adaptation Options* (Peterson et al. 2011).

3.7 Wildlife

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Wildlife Resources Report by A. Glidden (2016), available in the project record. Reference information is contained in the full specialist report.

3.7.1 Methodology

The wildlife resource indicators used for analyzing the impact of the proposed alternatives are displayed in **Figure 66**.

Figure 66. Wildlife Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Habitat for threatened species- spotted owls, lynx, and Critical Habitat (CH) for lynx.	Changes to suitable habitat	Acres of habitat change, % landscape.	P/N #4	ESA, Forest Plan, NWFP, Recovery Plan
		Road changes- miles		
Habitat for sensitive/focal species- goshawk, gray flycatcher, white-headed woodpecker and western gray squirrel.	Changes to suitable habitat	Acres of change, % landscape.	P/N #4	NFMA, Forest Plan, Executive Order 13186
		Road changes- miles		
Habitat for MIS for mature/old growth forest (spotted owls), winter range (mule deer) and lodgepole pine (lynx).	Changes to habitat	Acres of change, % landscape/area.	P/N #4	NFMA, Forest Plan, Restoration Strategy, Revised Recovery Plan for Northern Spotted Owl, Canada Lynx Conservation Assessment and Strategy
		Road changes- miles		
Habitat for Landbirds	Changes to habitat	Acres of change, % landscape/area.	No	Migratory Bird Treaty Act and Executive Order 13186

GIS comparison of habitat types and amount of habitat changed by project activities, field and literature review, and review of district observation database. EMDS computer modeling of habitat and analysis of historical and future range of variability, with field validation. Surveys for spotted owls and goshawks.

Resource Indicator: Change to Habitat for Threatened species- spotted owls, lynx, Critical Habitat for lynx.

Habitat for spotted owls, lynx and Critical Habitat for lynx is present in the analysis area. The basis for effects will be the changes in amount and quality of late/old mixed conifer forest habitat for spotted owls, and changes to roads in suitable habitat.

Lynx habitat will be evaluated by structural stage of habitat within the subalpine fir zone in Lynx Assessment Units (LAUs), and the capability to support the primary prey species of the lynx-snowshoe hare. Critical Habitat for lynx will be assessed by the effects of the treatments on the Primary Constituent Elements (PCEs) of the habitat. Changes to roads in suitable habitat will also be measured.

Resource Indicator: Change to Habitat for Sensitive Species- goshawk, gray flycatcher, white-headed woodpecker and western gray squirrel.
Goshawks use late/old structure forest, aspen stands and large trees. Evaluation of habitat will be based on change to these features. If active territories are found, changes to habitats within the territory or post-fledgling area will be assessed. Roads allow access for falconers to collect young birds, a permitted activity in Washington State. Road changes will be measured.

Gray flycatchers use open ponderosa pine/bitterbrush/bunchgrass stands. Assessment of habitat will be based on the stand changes in the hot/dry and warm/dry environmental zones, and changes to roads in suitable habitat.

White-headed woodpeckers are a focal species for dry forest management, and a sensitive species. Indicators for this species and habitat will be potential habitat changes in hot/dry and hot/warm/dry environmental zones, measured by acres treated, and changes to roads in suitable habitat.

Western gray squirrels use ponderosa pine and Douglas-fir stands, and adjacent riparian black cottonwoods. Ideal conditions may be a balance between open conditions that encourage pine seed production and clumping of trees allowing arboreal travel, secure nesting sites and patches of high canopy closure that produce abundant fungi. Indicators used for this species will be changes in stand structure and open roads.

Resource Indicator: Change to Habitat for MIS for mature/old growth forest (spotted owls), winter range (mule deer) and lodgepole pine (lynx).
Mature/old growth stands, winter range and lodgepole pine stands are found in the analysis area and provide important, and often limited, habitats for many wildlife species.

The late/old successional habitat was modelled using the EMDS process. Changes to this habitat type will be described in the vegetation resources report (Daly 2016). Large trees will not be harvested. Winter range is delineated by Forest Plan management areas and will be assessed using changes to cover and forage acres, and changes to roads in suitable habitat. Lodgepole pine habitats and boreal forest types used by lynx will be assessed by acres change to stands within the Lynx Assessment Units (LAUs) and habitat within the LAUs (in the Changes to Habitat for Threatened Species-lynx section above).

Resource Indicator: Change to Habitat for Landbirds

The project area has four primary environmental zones that are habitat for a variety of landbirds. Figure 67 below lists the types:

Figure 67. Environmental Zones for Landbird Analysis

Envirozone	*% of Project Area*
Hot-dry Shrub/steppe	21%
Hot/Warm-dry	42%
Cool-Dry	18%
Cool/Cold Mesic	18%

Focal species for the hot/dry and hot/warm ponderosa pine types are white-headed woodpeckers, gray flycatchers, flammulated owls, and chipping sparrows. For the higher elevation mixed conifer habitats, focal species are varied thrush, brown creepers, and goshawks. Ruffed grouse, yellow warbler and willow flycatchers are focal species for riparian and deciduous habitats. Treatments and effects to suitable habitat will be analyzed.

3.7.2 Intensity Level Definitions

Type of Impact:

- Adverse: Degrades habitat or reduces amount of habitat.
- Beneficial: Improves habitat quality or increases amount of habitat.

Duration of Impact:

- Short-term: Up to 5 years.
- Long-term: 10 or more years.

Intensity of Impact:

- None: No effect.
- Negligible: Effect is not measurable.
- Minor: Effect is small in scale or amount.
- Moderate: Effect would cause a measurable and noticeable loss of habitat.
- Major: Effect would cause substantial habitat loss or gain and may affect populations.

3.7.3 Affected Environment

Figure 68 summarizes the wildlife resource indicators and the existing condition.

Figure 68. Wildlife Resource Indicators and Measures for the Existing Condition

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
Habitat for threatened species- spotted owls, lynx, and Critical Habitat (CH) for lynx.	Suitable Spotted Owl Habitat (late old successional habitat)	Nesting, Roosting, Foraging habitat (NRF) area	1,054 acres
		Open roads in NRF	2.2 miles

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
	Suitable Lynx habitat in LAUs	Early successional habitat in subalpine fir zone	Spirit Mountain-300 ac. Methow Gold- 206 ac.
		Open roads in habitat	2.6 miles
	Critical Habitat for lynx	Acres of designated habitat	12,890 acres
		Open roads in habitat	9.9 miles
Habitat for sensitive/focal species- goshawk, gray flycatcher, white-headed woodpecker and western gray squirrel.	Suitable habitat	Goshawk- dense stands with large trees.	13,022 acres (38% of non-Wilderness project area)
		Open roads in habitat	34.8 miles
	Suitable habitat	Gray flycatcher- mid-successional ponderosa pine and shrub-steppe.	21,743 acres of potential habitat (64% of non-Wilderness project area)
	Suitable habitat	Western gray squirrel- Ponderosa pine/mixed conifer and riparian habitats.	21,743 acres of potential habitat (64% of non-Wilderness project area)
		Open roads in habitat	45.3 miles in habitat
	Suitable habitat	White-headed woodpecker	21,743 acres of potential habitat (64% of non-Wilderness project area) 0 ac. Buttermilk (below historical levels) 38 ac. Libby (lower end of historical range)
Habitat for MIS for mature/old growth forest	Spotted owls	See Spotted owls, above	See Spotted owls, above

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
(spotted owls), winter range (mule deer) and lodgepole pine (lynx).	Winter range	Cover:forage ratios/Forest Plan standards	MA 14: 52% cover (SIT-22%, WT-29%) MA 26: 35% (SIT-16%, WT-19%)
		Open roads in habitat	23.8 miles
	Lodgepole pine	See Lynx and Critical Habitat, above	See Lynx and Critical Habitat, above
Habitat for Landbirds	Pine, mixed conifer and deciduous/riparian habitats.	Effects to suitable habitats	Ponderosa pine- 8,426 acres. Mixed conifer- 1,817 acres. Riparian- 3,412 acres Deciduous- 430 acres

Resource Indicator: Change to habitat for threatened species
Spotted owls: Spotted owls use late/old mixed conifer habitat for nesting, roosting, foraging and dispersal habitat, generally in the more mesic areas of the district, although nest sites in dry douglas-fir/ponderosa pine stands are also used. Exclusion of fire from dry and mesic forests has increased suitable habitat conditions for spotted owls, but simultaneously resulted in greater risk of habitat loss due to fire (Buchanan et al.1995; Everett et al.1997). Everett et al. (1997) suggested that while vegetation manipulation to reduce fire hazard may create less optimal habitat for the Northern spotted owl, habitat effects from vegetation treatments should be considered against the risk of stand replacement fires and the loss of nesting and roosting habitat over large areas. Over 50% of the Northern spotted owl nest-sites in the eastern Cascades of Washington occur within dry and mesic forests (in Gaines et al. 2010), which are at risk of uncharacteristic fire (Everett et al. 2000; Hessburg et al. 2007).

While surveys done in the 1980's and 1990's have documented the presence of spotted owls in the project area, follow-up visits indicated that they were either transient through the area or resident single birds. No nests or activity centers have been located. Recent surveys have not located spotted owls in the project area. The western edge of the project area, with its primarily warmer and drier forest types, may be a dispersal route between more mesic habitats in the Twisp River drainage and higher elevations of Gold Creek. Currently, 1,054 acres have been identified as nesting, roosting, foraging habitat (NRF) and 4,113 acres as dispersal habitat, using a combination of EMDS modelling, GIS, and field verification. The NRF habitat is generally marginal, and found primarily in riparian stringers and small, isolated patches. It is

unlikely that enough habitat is present in these drainages to support spotted owls, and potential for these vegetation types to produce sustainable owl habitat is extremely limited. Approximately 4,112 acres of dispersal habitat are found in the project area. Like the NRF habitat, these denser stands are at high risk of wildfire and not sustainable.

Approximately 2,335 acres of the analysis area are designated as Late-successional reserve (LSR), to be managed for late-successional habitat for spotted owls and other species. Currently, about 118 acres (5% of the LSR within the project area) of NRF habitat and 306 acres (13% of the LSR within the project area) of dispersal habitat are present in the area.

Habitat in the project area has changed due to fire suppression and logging, which have resulted in reduced numbers of large trees, fragmented stands, and forest conditions dominated by dense multilayered stands of smaller trees that are at risk for wildfire, insects and disease, and that also compete with larger trees. Old forest structural attributes (large trees, large snags and down wood) in these dense overstocked stands are at a high fire risk (Everett et. al. 1997).

Approximately 2.2 miles of open road intersect NRF habitat in the analysis area, which could cause disturbance to spotted owls.

Lynx: Lynx are medium size cats that inhabit mesic coniferous and coniferous/deciduous forests that have cold, snowy winters and provide a prey base of snowshoe hare. Good snowshoe hare habitat is comprised of dense, horizontal vegetation 3-10' above the ground or snow level that provides both browse and cover.

The project area is in the core area for lynx, where long-term persistence of lynx has been documented. Portions of two lynx analysis units (LAUs) are present in the analysis area, and lynx habitat (subalpine fir zone) is present in the western, higher elevation portion of the LAUs. Habitat in both LAUs is dominated by mid-successional structures, with little stand initiation phase that would provide hare browse. There are approximately 2,274 acres of lynx habitat within the LAUs.

The Lynx Conservation Assessment and Strategy (LCAS), considered some of the best available science currently, provides conservation measures that are the basis for ESA consultation with US Fish and Wildlife Service. Measures applicable to this project are, in part:

- Maintain a mosaic of lynx habitat across LAUs.
- Design vegetation management to develop and retain dense horizontal cover.
- Do not reduce stem density through thinning, until stands no longer provide winter hare habitat.
- Retain mature multi-story conifer stands providing horizontal cover.
- No more than 30% of the habitat in an LAU is in early stand initiation structural stage or treated to remove horizontal cover (i.e. does not provide winter hare habitat.).
- When designing fuels reduction projects, retain patches of untreated areas of dense horizontal cover within treated areas.
- Management change of habitat on federal lands that creates early stand initiation structural stage or treated to reduce horizontal cover should not exceed 15% of lynx habitat on federal lands within a LAU over a 10-year period.

In addition, the LCAS notes that in drier forests adjacent to the boreal forest, fire suppression may have resulted in unnaturally dense fuels, and restoration of these communities may be desirable to reduce the risk of spreading frequent of severe fires into lynx habitat. This is the case in the project area.

The EMDS model does not consider lynx habitat. However, it does look at stand structures and vegetation types in the cold forest that lynx prefer. In the cold forest areas, the young forest multistoried structure and stem-exclusion single story structure are overrepresented, in comparison to historical levels, resulting in reduced diversity of habitat types across the landscape. Providing a mosaic of stand structures, including dense early-successional stands and mature multi-story coniferous stands that will produce winter snowshoe hare habitat over time, across the landscape, is important for lynx conservation.

Recommendations for the cold forest type from the EMDS analysis include reducing area and patch size in the young forest multi-storied stand type, and to a lesser extent, the stem-exclusion single story type, and reducing the area in subalpine fir types. However, there is limited opportunity to restore stand structures within the lynx habitat, due to topography, elevation, and the existing transportation system.

Approximately 2.6 miles of open road are located within the mapped lynx habitat in LAUs which could result in disturbance or habitat disturbance.

Critical habitat for Lynx: Approximately 12,890 acres within the project area are designated Critical Habitat for lynx. The Fish and Wildlife Service designated boreal (northern, high-elevation moist forests) forest landscapes providing a mosaic of forest structures as Critical Habitat. The primary constituent elements (PCEs) for critical lynx habitat are:

- the presence of snowshoe hares and lynx preferred habitat conditions, which include dense understories of young trees, shrubs or overhanging boughs that protrude above the snow, and mature multistoried stands with conifer boughs touching the snow surface;
- winter snow conditions that are generally deep and fluffy for extended periods of time;
- sites for denning that have abundant coarse woody debris, such as downed trees and root wads;
- matrix habitat (e.g., hardwood forest, dry forest, non-forest, or other habitat types that do not support snowshoe hares) that occurs between patches of boreal forest in close juxtaposition (at the scale of a lynx home range) such that lynx are likely to travel through such habitat while accessing patches of boreal forest within a home range (USFWS, 2009).

Critical Habitat consists of areas considered to be essential to the conservation of the species and which may require special management considerations or protection. Critical Habitat receives protection under section 7 of the Endangered Species Act, and agencies must ensure that any actions are not likely to result in destruction or adverse medication of Critical Habitat. Some of the activities that may affect Critical Habitat for lynx include actions that would remove understory vegetation in boreal forest on a large scale, actions that would result in loss or conversion of boreal forest on a large scale, and actions that would increase traffic volume and

speed in lynx Critical Habitat. In matrix habitat, activities that change vegetation structure or condition would not be considered an adverse effect to Critical Habitat unless they would create barriers or impede lynx movement between habitat components.

In the North Cascades in Washington, most lynx occur above 4,101 ft and select Engelmann spruce-subalpine fir forest cover types in winter (Koehler et al. 2008; Maletzke 2004). Lynx in this area avoid Douglas-fir and ponderosa pine forests, openings, recent burns, open canopy and understory cover, and steep slopes (Koehler et al. 2008).

Boreal forest in the project area is primarily confined to the western half of the LAUs. Critical Habitat is delineated along the northeast and southcentral ridgelines dividing the Libby watershed with watersheds to the north and south. These areas have some cold/cool forest habitat, but are generally warmer drier forest types that aren't providing quality lynx habitat or connections to other LAUs. This is not likely to change, given the warming climate. In the (non-Wilderness) project area, 12,890 acres are designated Critical Habitat for lynx. Approximately 4,604 acres are within the mapped lynx habitat. Early successional habitat is estimated at 853 acres, 7% of the Critical Habitat in the project area.

Approximately 9.9 miles of road are found in Critical Habitat, which could result in disturbance or habitat disturbance.

Resource Indicator: Change to Habitat for Sensitive and Focal Species
Northern Goshawk: Goshawks are a focal species that use stands with large trees, dense canopies, and high canopy closures for nesting. Goshawk nesting habitat is generally composed of mature and older forests (McGrath et al. 2003). In eastern Washington, nest stands typically have a relatively high number of large trees, high canopy closures (>50%), multiple canopy layers, and a relatively high number of snags and downed wood (Finn 1994, McGrath et al. 2003). Although old-growth characteristics are important to breeding goshawks, McGrath et al. (2003) found that old-growth stands were used for nesting only in proportion to their availability, while closed canopy stem exclusion stands were used more than expected based on availability.

Post-fledgling areas (PFAs) surround the nest area and are used by juveniles until they no longer depend on adults for food. PFAs provide hiding cover and foraging habitat for juveniles. PFAs consist of a variety of forest types and conditions, but in eastern Washington, were composed largely of structurally complex late-successional forests (McGrath 1997). Hargis et al. (1994) found that foraging occurs in various cover types and structural stages and that the juxtaposition of several habitat types may enhance foraging.

Densely canopied stands with large trees suitable for nesting goshawks are found across the analysis area, and estimated at approximately 6,090 acres in Libby Creek (27% of non-Wilderness watershed in project area) and 6,932 acres in Buttermilk Creek (63%). Goshawks have been documented in the project area, although current surveys have not located active territories.

Goshawks cover large areas and use many habitats while foraging, and may be found across the project area. Approximately 34.8 miles of open roads are found in the potential habitat.

Gray Flycatchers: Breeding habitats for the gray flycatcher are shrub-steppe and open woodland. On the Okanogan-Wenatchee National Forest, habitat is scattered open ponderosa pine with bitterbrush and bunchgrass understories (Kent Woodruff, USFS, personal communication). In the central Washington Cascades, ponderosa pine trees within gray flycatcher territories are mid-successional size (mean DBH 11-13") (Altman and Woodruff 2011). Nests are generally open-cups in trees or shrubs within a few meters of the ground, up to 20 meters, and nest-building and egg-laying occur in early to mid-June in Washington (Altman and Woodruff 2011).

Habitat loss and alteration that reduces the amount or suitability of flycatcher habitat is the most likely threat to the gray flycatcher population (Altman and Woodruff 2011) and recent changes in fire regimes threaten persistence of the primary habitat type for this species.

Gray flycatcher habitat is abundant in the project area, in the hot/dry and warm/dry environmental zones and is estimated at approximately 21,743 acres. These two habitats comprise approximately 64% of the project area outside of Wilderness.

White-headed Woodpeckers: White-headed woodpeckers inhabit low-elevation dry forests, and are a focal species for dry forest management in the eastern Washington Cascade Range, as well as an R6 sensitive species. White-headed woodpeckers are most abundant in burned or cut stands with residual large live and dead pine trees (Raphael and White 1984; Raphael et al. 1987). Many low-elevation dry forest species have been considered at risk due to the closing of dry forest canopies with fire exclusion, loss of large old ponderosa pine trees to logging, decline of herb and shrub understories from stand-canopy closure, and exclusion of low-intensity burns (Lehmkuhl et al. 1997; Wisdom et al. 2000).

Approximately 64% of the project area is classified as dry forest habitat. In the south end of the project area, the Carlton Complex Fire burned about 800 acres in 2014 and will provide additional habitat. There are 45.3 miles of open road in the dry forest habitat.

The EMDS model was run for white-headed woodpecker habitat, and was modelled as ponderosa pine cover type with medium or large tree overstory of 30-40% canopy closure and elevations between 3,000' and 4,000'. The EMDS model shows no current high-quality habitat for white-headed woodpeckers in the Buttermilk drainage. Potential habitat occurs across 2% of the landscape, above historic levels which ranged from 0.01% to 0.3%. The mean patch size is slightly above historical levels and patches are closer currently than historically.

In the Libby drainage, the amount of current high-quality habitat for white-headed woodpeckers is within the historic range, although towards the lower end (range is 0.01-4.15%). Patch density, large patch index, and mean patch size are within HRV, although all towards the lower end of the range. Mean nearest neighbor value is below historical levels, which means that patches are closer than they were historically.

Western Gray Squirrels: Western gray squirrels inhabit mast-producing conifer-hardwood forests throughout their range. In Okanogan County, gray squirrels use ponderosa pine and Douglas-fir stands, and adjacent riparian black cottonwoods (Linders and Stinson 2007). Sites with more large (>15" DBH) trees may be better habitat because they provide more food, better

cover, more cavities, and, often, interlocking crowns important for nest site security and arboreal travel.

Approximately 64% of the project area is comprised of forested stands that could be habitat for gray squirrels, and they have been documented in the project area. Generally, lower elevation forested stands in the project area have the potential to provide adequate nest sites and ample potential for arboreal travel. Larger pines, and a variety of shrubs, produce seeds and berries for a diversity of food resources for squirrels. Red squirrels are abundant in the area and can be expected to compete for these foods.

Mortality by vehicles is a threat to squirrel populations, in addition to habitat loss and disease (Linders and Stinson 2007). Approximately 45.3 miles of open roads are found in the habitat for western gray squirrels.

Resource Indicator: Change to Habitat for Management Indicator Species
Spotted Owls: included in first resource indicator.

Winter Range for Mule Deer: Mule deer are a Management Indicator Species for winter range, and the Okanogan National Forest Land and Resource Management Plan contains standards and guidelines for winter range cover and access. Since the time that the Forest Plan was written, studies have found that thermal cover is not as critical as forage quality and quantity for winter survival of ungulates (Forest Restoration Strategy; USDA 2012a). Cook et al. (1998) concluded that their findings, combined with those of other thermal cover studies (e.g., Robinson 1960; Freddy 1986), offered strong evidence that influences of thermal cover on animal performance and, by extension, population dynamics was rarely of consequence. Cook et al. (2005) noted that there are tradeoffs between providing dense forest cover and providing forage resources, and concluded that cover is needed where security is low or where snow accumulations are factors limiting animal performance. Mysterud and Ostbye (1999) found that, although cover is important for habitat selection of temperate ungulates, there is no hard evidence that cover affects demography so much that it limits population growth in forested areas, and that there is no evidence that specific arrangements of food and cover areas confer any large advantage to deer. The Okanogan-Wenatchee Restoration Strategy suggests that emphasizing the reduction of road density and enhancement of forage, can allow reduction in thermal cover while meeting the intent of standards for deer winter ranges, to resolve the potential conflict between restoring forests and winter range thermal cover.

Mule deer populations in Washington Department of Wildlife's Region 2, where the project is located, have experienced a gradual long-term decline in numbers which is attributed to reduced shrub diversity, declining productivity of aging shrubs and lack of recruitment of new shrubs due to fire suppression (Fitkin and Heinlen 2012; 2015), rather than thermal cover. Herd growth has plateaued, and productivity and recruitment has fallen off as the herd reached 20-25,000 animals, which appears to be the landscape carrying capacity for deer (Fitkin and Heinlen 2012). In 2014, wildfires burned about 40% of the winter range in the Methow watershed, including high density winter range areas (Fitkin and Heinlen 2016). Additional large fires in 2015 continued this trend. Initial review indicates that much of the winter range in the area burned in the last 2 years and will likely impact the winter range carrying capacity for deer until shrubs reestablish and grow large enough to function as winter browse (Fitkin and Heinlen, 2016).

The current condition of thermal cover on the winter range in the project area is displayed in **Figure 69**.

Figure 69. Cover on Deer Winter Range

	Current Condition		
Management Area	***Winter thermal cover***	***Snow-intercept thermal cover***	***Total***
Standards & Guidelines	25%	15%	40%
MA-14	29%	22%	51%
MA-26	19%	16%	35%

These cover amounts are the result of fire suppression over the last century, which has led to increased acreages in denser stands that provide more thermal cover, and less forage than more open conditions provide. Dense stands are not a sustainable condition, and are at risk of mortality from insects, disease and wildfire.

Access: Road densities are analyzed in the Transportation section. Open road density standards for deer winter range are 1 mile per square mile in MA-26 and 2 miles per square mile in MA-14. Road densities in the winter range land allocations for the project are below the maximum densities in each discrete management area. Approximately 23.5 miles of open roads are found in winter range in the project area, which could result in disturbance or habitat avoidance. However, the Forest roads are closed by snow during the critical winter period.

Lynx: included in the first resource indicator.

Resource Indicator: Change to Habitat for Landbirds
Landbirds are an issue if habitat for the focal landbirds is present and would be affected by project activities. Direction for landbird conservation is provided by the Migratory Bird Treaty Act and Executive Order 13186 Responsibilities of Federal Agencies to Protect Migratory Birds and MOU 08-MU-1113-2400-264 Memorandum of Understanding between the U.S. Department of Agriculture Forest Service and the U.S. Fish and Wildlife Service to Promote the Conservation of Migratory Birds.

Guidance for landbird conservation is provided by the Landbird Strategic Plan and The Conservation Strategy for Landbirds in Oregon and Washington (Altman 2000a; b, and Altman and Holmes 2000).

Project area habitat has changed over the last century, and current stands are denser, more uniform, and have fewer large trees in comparison with historical forests (Franklin et al. 2008). In addition, fewer large snags are available due to firewood cutting and danger tree management. This has resulted in a decrease in habitat quality in the project area for chipping sparrows and flammulated owls. The increase in density and multistoried habitat may have improved conditions for varied thrushes.

White-headed woodpeckers, gray flycatchers and goshawks have been discussed in the previous resource indicator.

Figure 70. Landbirds and Conservation Strategies

Species	*Conservation strategies*
Chipping sparrow (focal species for open understory)	Create open stand conditions and open understory with burning and thinning.
Flammulated owl (focal species for large snags)	Retain large snags. Open stands, but leave some thickets. Limit snag loss to firewood cutting.
Varied thrush (focal species for structural diversity)	Retain structurally diverse, multi-story conifer forest.
Brown creeper (focal species for large trees)	Retain large trees.
Ruffed grouse	Riparian and deciduous habitat
Yellow warbler	Riparian subcanopy foliage
Willow flycatcher	Dense riparian shrubs

3.7.4 Environmental Consequences

3.7.4.1 Considered, but not Analyzed in Detail

The Wildlife Resource Report(Glidden 2016) describes in detail the wildlife species that were considered but not analyzed in detail.

3.7.4.2 Alternative 1

3.7.4.2.1 Effects

Resource Indicator: Changes to Habitat for Threatened species

Spotted owls: If the no action alternative is implemented, stands would continue to increase in density, and fuel loadings would increase. Development of large trees that are important habitat elements for spotted owls, and limited in the project area, would be retarded by competition from the smaller trees. Competition would also result in mortality of the large trees, producing large snags, which are also important habitat elements. The few dense multistoried stands currently providing marginal owl habitat would be at elevated risk from high intensity wildfire due to abundant ladder fuels, which could carry fire into the crowns. High severity wildfire alters the forest structure associated with spotted owl nest and roost sites: high canopy closure, large-live tree basal area, and total live-tree basal area (Gaines et al. 1997; Roberts et al. 2008; Bond et al. 2009). (Low to moderate severity wildfires may have little or slightly positive impacts on spotted owls (Bond et al. 2002; Roberts et al. 2008; Bond et al. 2009).

In the short-term, current NRF and dispersal habitat would not be degraded or downgraded with implementation of the no action alternative and habitat fragmentation would not increase. In the

long-term, stands would not become NRF or dispersal habitat as quickly, (if at all) in comparison to the action alternative. There would be no short-term effect. The long-term effect of the no-action alternative would be a neutral effect to habitat, because of the increased risk of habitat loss through wildfire and slowed development of large tree habitat used as nesting structures balanced by increased stand densities, which provide better habitat for owls.

Lynx and Critical Lynx Habitat: If the no action alternative is selected, the lynx habitat in the LAUs and in critical habitat would remain the same in the short-term, and increase in stand densities and tree size, over time. If disturbance is absent, over time, the stand initiation stage stands would grow into stands of larger size trees not providing concentrated hare forage. Open-canopied stands with understories providing hare foods would eventually become less open, and understory forage would be reduced. This would reduce the prey base for lynx, and reduce capability of the LAU and Critical Habitat to support lynx. This would have a minor adverse effect in the long-term in lynx habitat, because there are few units proposed in boreal habitat and a larger adverse effect (long-term) in critical habitat, because critical habitat was designated in drier forest types as well as boreal forest.

Resource Indicator: Changes to Habitat for Sensitive Species
Northern Goshawk: If the no action alternative is implemented, over time, denser stands would develop, and areas with high canopy closures and large trees would provide suitable habitat for goshawks. However, because goshawks use a more open understory, increased densities in the understory could be detrimental. Large trees, snags and down wood, important for nests and prey habitat would develop more slowly due to competition, and would be at higher risk than in the action alternative, due to wildfire and insect activity. The no action alternative would have mixed effects in the long-term- the understory would become denser and potential nest trees would develop more slowly, and these would be at higher risk for fire and insect activity, which is a negative effect to goshawks, but the overall canopy closures would also increase, providing more habitat for goshawks.

Gray Flycatcher: Fire suppression has resulted in higher stand densities and reduced understory vegetation, resulting in a reduction in habitat suitability for gray flycatchers. The no action alternative would continue this trend. As forest canopies close, understory shrubs would be shaded out, and fewer nesting opportunities would exist. Implementation of the no action alternative would result in long-term moderate adverse effects due to increased stand densities.

White-headed Woodpecker: Implementation of the no action alternative would result in higher stand densities and increased canopy closures, resulting in a reduction in habitat suitability for white-headed woodpeckers. In the long-term, the large ponderosa pines used for nesting would be at a higher risk from wildfire, due to the presence of ladder fuels. Competition from smaller trees would result in mortality of the large pines, which would reduce nesting opportunities. Implementation of the no action alternative would result in long-term moderate adverse effects due to increased stand densities.

Western Gray Squirrels: With implementation of the no action alternative, stand densities would continue to increase, providing increased arboreal travel and fungi foods. Competition on large pines from smaller trees would slow their growth, and reduce production of seeds, which are an

important winter food source. Mortality due to vehicle strikes would continue on 45.3 miles of open roads. Implementation of the no action alternative would result in long-term mixed effects due to increased stand densities and reduced growth of large pines.

Resource Indicator: Habitat for Management Indicator Species
Spotted Owls- analyzed in first resource indicator.

Winter Range for Mule Deer: Implementation of the no action alternative would allow stand densities to continue to increase, providing more thermal cover and less forage for mule deer. This would result in an overall decline in the ability of the winter range to support mule deer over time. Implementation of the no action alternative would result in long-term moderate adverse effects due to a reduction in forage species. The no-action alternative would result in road densities being maintained at current levels. The proposed action would close and decommission roads, resulting in reduced action and higher quality habitat for mule deer. Implementation of the no action alternative would result in long-term minor adverse effects due to road effects in comparison with the action alternatives.

*Lynx***-** analyzed in first resource indicator.

Resource Indicator: Changes to Habitat for Landbirds
If the no-action alternative is selected, denser stand conditions would be maintained, reducing habitat quality for species using open stands (chipping sparrow, white-headed woodpecker, gray flycatcher), large trees (spotted owl, goshawk, brown creeper) or large snags (flammulated owl) and improving habitat availability for species preferring dense stands and smaller trees (varied thrush). Degraded riparian habitats would be maintained in their current condition, resulting in poor quality habitat for species using riparian habitats (yellow warbler, willow flycatcher, ruffed grouse). No road decommissioning would occur, resulting in continued snag loss, disturbance, habitat avoidance, and access-related mortality. Implementation of the no action alternative would result in mixed effects to landbirds. There would be a long-term moderate adverse effect to landbirds that prefer open stands, and a long-term moderate beneficial effects to species preferring denser conditions. There would be a long-term moderate adverse effect to landbirds resulting from roads and road use.

3.7.4.3 Alternative 2 and 3 – Proposed Action Effects Common to Both Action Alternatives or to Alternative 2 Only

3.7.4.3.1 Effects
The effects of the proposed actions of both alternatives or to Alternative 2 only are summarized in **Figure 71**.

Figure 71. Wildlife Resource Indicators and Measures for Alternative 2

Resource Element	Resource Indicator	Measure	Alternative 2
Habitat for threatened species- spotted owls,	Suitable Spotted Owl Habitat (late old successional habitat)	Nesting, Roosting, Foraging habitat (NRF) area- acres treated	1,022 acres (-3.0%)

Resource Element	Resource Indicator	Measure	Alternative 2
lynx, and Critical Habitat (CH) for lynx.		Open roads in NRF	17.2 post-project
	Suitable Lynx habitat in LAUs	Early successional habitat in subalpine fir zone- acres treated	Spirit Mountain- 5 ac.(2%) treated Methow Gold- 50 ac. (41%) treated
		Open roads in habitat- mi.	2.6 mi. post-project
	Critical Habitat for lynx	Acres of designated habitat with treatments	2,137 acres treated (17%)
		Open roads in habitat	15.7 miles post-project
Habitat for sensitive/focal species- goshawk, gray flycatcher, white-headed woodpecker and western gray squirrel.	Suitable habitat	Goshawk- dense stands with large trees.	11,712 acres (34% of non-Wilderness project area)
		Open roads in habitat	40.2 post-project
	Suitable habitat	Suitable habitat improved (acres; sensitive species- gray flycatcher, white-headed woodpecker and western gray squirrel.)	1,962 acres of potential habitat improved. (9% of the habitat)
		Open roads in habitat	51.4 post-project
Habitat for MIS, winter range, mule deer.	Spotted owls	See Spotted owls, above	See Spotted owls, above
	Winter range	Cover:forage ratios/Forest Plan standards	MA 14: 33% cover (SIT-10%, WT-24%) MA 26: 33% (SIT-16%, WT-17%)
		Open roads in habitat	21.0 post-project
	Lodgepole pine	See Lynx and Critical Habitat, above	See Lynx and Critical Habitat, above

Resource Element	Resource Indicator	Measure	Alternative 2
Habitat for Landbirds	Pine, mixed conifer and deciduous/riparian habitats.	Effects to suitable habitats	Ponderosa pine- 8,426 acres treated (39%) Mixed conifer- 1,817 acres treated (14%) Riparian- 628 acres (plus 40 acres aspen) (20%) Deciduous (aspen) 286 acres

Resource Indicator: Changes to Habitat for Threatened Species

Spotted owls:

In east-side habitats of the Washington and Oregon Cascade Range, the only viable conservation strategy is to actively manage fire-prone forests and landscapes to sustain spotted owl habitat (USDA 2012a). The proposed treatments in the action alternatives would achieve this, and are consistent with the revised recovery plan for spotted owls (USFWS 2011), by treating primarily areas that are not currently providing habitat, to better protect habitat from large scale, high-severity fires and to set appropriate stands (which are very limited in the analysis area) on a trajectory to become habitat in the future. Suitable habitat in the analysis area is inadequate to support owls, and marginal due to small isolated stands on the edge of the range. Two of those stands (32 acres) would be thinned to retain the large tree component, while retaining adequate canopy closure to function as NRF.

Disturbance from noise and human presence could occur during implementation of all treatments, particularly those using heavy equipment and chainsaws. Surveys were completed in areas where NRF habitat was concentrated, with no responses from spotted owls.

Silvicultural treatments in NRF: **Figure 72** displays the extent of the silvicultural treatments for Alternative 2 in suitable owl habitat (NRF).

Figure 72. Silvicultural Treatments in Spotted Owl Habitat (NRF)

Prescription	***NRF (acres)***
Dry Forest with mistletoe sanitation	3*
Dry Forest Restoration	1*
Moist Forest Thin	32
Post and Pole	0
Regeneration	0

Total	***32***

*Mapping errors to be resolved, no actual NRF loss.

Moist forest treatments would occur in 32 acres (3%) of marginal NRF habitat for spotted owls. Treatment prescriptions for this type would limit size of understory trees that would be cut around the largest trees, to 21" DBH, and retain snags and defective trees.

Silvicultural treatments that change the overstory in owl habitat would open the canopy and slightly degrade NRF habitat. This would be a minor (32 acres), short- to medium-term (1-10 years), negative effect to the habitat, followed by a minor long-term beneficial effect (because the treatments would retain large trees on the landscape, and reduce risk of fire and insect activity).

Silvicultural treatments in dispersal habitat: Approximately 515 acres of dispersal habitat would be thinned (about 11% of the dispersal habitat), which would open the canopy and slightly degrade this habitat type. This includes treatments that remove mistletoe infections, which produce deformed branches often used for nesting. This treatment is planned for 127 acres in dispersal habitat (3% of the dispersal habitat). In the short-term, this would decrease nest site availability in stands that may become habitat in the future, while improving growth on remaining trees in the longer term. (These treatments do not occur in stands currently providing suitable NRF habitat.) Regeneration harvest would occur on 56 acres of dispersal habitat (1%), which would downgrade the habitat to non-habitat.

The amount of dispersal habitat for spotted owls would be reduced by silvicultural treatments in the short and medium term, likely for a minimum of 10 years, (until the medium and large trees released from understory competition grow enough to provide a high canopy closure). This would make the project area even less suitable for spotted owls than it is already. There would be a moderate (11% degrade/downgrade of dispersal habitat), adverse effect to dispersal habitat in the short-to medium term. Approximately half of this reduction would occur in the northeastern portion of the analysis area, where dry forest conditions interspersed with non-forest habitat adjacent to private land and the eastern edge of the owl's range, make this area a poor candidate for managing as owl habitat. In the longer term, accelerated growth of large trees would occur more quickly than if left unmanaged, providing better habitat over time for spotted owl and other species using large trees.

Silvicultural treatments would also result in moderate beneficial effects to the dispersal habitat, in the short and longer term (immediately to >20 years). Release of large and medium trees would reduce competition on the remaining trees, accelerating their rate of growth into larger trees. It would also reduce the ladder fuels that could carry fire from the ground into the canopy, and reduce risk of losing the stands of large trees. This would improve habitat at the individual stand and at the landscape level for spotted owls.

In all prescriptions except regeneration harvest (56 acres of the 4,112 acres of dispersal; 1%), NRF and dispersal stands will retain some habitat function as foraging habitat, post-treatment. Habitat would be slightly degraded for flying squirrels (Carey 2001; Lehmkuhl et al. 2006b) but habitat for woodrats and other prey (Lehmkuhl et al. 2006a), would be retained or would rapidly

recover functionality (in less than 5 years)(Irwin et al. 2012), and would provide a food source for owls. Variable thinning, which is planned for the project, is expected to be favorable compared to even-aged thinning because it creates within stand heterogeneity (Carey 2001; Lehmkuhl et al. 2006a, b). Carey found that after variable thinning treatments, total biomass of squirrels was enhanced within 5 years which would provide additional food for owls.

Ladder fuel treatments: Research suggests that thinning and burning treatments in dry coniferous forests have few detrimental effects on native understory vegetation (USDA 2012a). Ladder fuel thinning that affects the understory would have minor effects on the NRF and dispersal habitat. Understory fuels less than 8" DBH would be cut, piled and burned. These contribute little to canopy closures and are too small to provide shading, habitat for prey species or cover from predators. Removal of this component would reduce competition and risk of fire to the larger trees. Ladder fuel thinning would occur in less than 1 acre of NRF habitat and about 2,004 acres of dispersal habitat (about 50%). However, ladder fuel reduction (LFR) in non-habitat stands would result in reduced risk of crown fire across the landscape, which would protect existing owl habitat, as well.

Prescribed burning: Prescribed burning has less effect on overstory than thinning, and usually does not reduce tree density or basal area of the dominant overstory (USDA 2012a). Patchiness, structural complexity and habitat heterogeneity increase with prescribed burning, unless there are multiple entries or burn is large (greater than 1000 hectares; Pilliod 2006). Prescribed burning with low/moderate prescriptions would have minor negative effects on owl habitat in the short- to medium term (1-10 years). It would result in slightly more open canopies, loss of large, soft snags, and creation of small, hard snags. Beneficial effects would be increased diversity of structures and increased complexity of habitats which would increase foraging opportunities in about 5 years.

Fireline construction by machine and hand would be completed to support burns. None of the machine firelines are in suitable NRF habitat, but several are adjacent. Surveys have been completed and no responses were elicited from spotted owls.

Road actions: No temporary roads would be built in suitable NRF habitat. Several closed roads (ML 1) would be opened. While 2.4 miles would be opened, only 0.5 would be open to public use. The remainder would be open to administrative use, which is infrequent. Decommissioning of closed and open roads, opening of closed roads for administrative use, and changes in maintenance levels would occur, and could result in short-term disturbance to owls. There would be mixed effects to owls- a short-term minor adverse effect could occur during road actions (decommissioning, opening, closing), a moderate intensity, long-term benefit would occur, as decommissioned roads would eventually revegetate, possible providing additional habitat in 40 years or more.

Minor vegetation changes could occur as a result of the decommissioning or reopening, if small trees and shrubs are removed on the road bed.

Surveys have been completed and no responses were elicited from spotted owls.

Soils treatments: Soil treatments would occur in 28 acres of NRF and 21 acres of dispersal habitat. The tree component would not be changed, and this treatment would not change

habitat function. Timing restrictions would not be required, as surveys have been completed and spotted owls were not found. Disturbance to owls in the area, but undetected by surveys, could occur.

Wetland treatments: These treatments occur outside of suitable owl habitat, however, disturbance to adjacent habitat could occur. No timing restrictions were required, because surveys were completed in these areas, and no spotted owls were found.

Aquatic Projects: Vegetation effects would be minor for these projects, and large trees would not be affected. Timing restrictions for fish protection on the culverts would prevent disturbance to nesting owl season, as well.

Overall, considering all project components, the project would have minor (to NRF habitat) to moderate (dispersal habitat) short-term to medium-term (1-10 years), mixed effects for spotted owl habitat, and long-term moderate beneficial effects (because fire/insect activity risk would be reduced across landscape, and stands would be more likely to have large tree habitat suitable for owls). There is currently not enough habitat in the project area to support owls.

Summary of Effects on Spotted Owls: Alternative 2 may affect, but is not likely to adversely affect spotted owls. The area does not have enough habitat to support nesting owls currently. The limited suitable habitat is avoided in treatments, except for 32 acres which would be thinned to retain the largest trees. Surveys of the habitat concentrations have not elicited responses from spotted owls.

For owls as MIS- this alternative would have a small short-term negative impact, as vegetation treatments affect 3% of the current suitable, but unoccupied, habitat. Treatments across the landscape would accelerate the growth of large trees more suitable for owl habitat, and would reduce risk of large-scale fire on the habitats. The loss of unoccupied habitat and short-term disturbance would be minor at the Forest scale.

Lynx:
Silvicultural and fuels treatments: Approximately 1,770 acres of treatment would occur in the LAUs in the analysis area. However, only 55 acres occur within the boreal forest area where lynx are expected. In the Methow Gold LAU (Libby drainage), 50 acres of pre-commercial thinning (in plantations) would occur in stands that are typed as stand-initiation phase. Five acres of aspen understory treatment would occur in the Spirit LAU (Buttermilk). These stands have grown out of reach of hares and are no longer providing a food resource. All overstory treatments would result in more open habitat that will generate browse for hares, an important prey item for lynx. This effect would occur rapidly after overstory change (1 to 10 years; Pilliod 2006), and persist until shrubs and tree limbs grow out of reach of hares. Slash would be hand-piled.

Soils treatments, Wetland treatments: These are not proposed in the LAUs.

Fisheries and aquatics projects: Several projects aimed at improving aquatic habitat condition are proposed in Alternative 2 and are located in lynx habitat in the LAUs. Installation of culverts, coarse wood and beaver dam analogs would result in short-term noise and human presence in lynx habitat. Disturbance could occur, but lynx do not appear to be particularly sensitive to

human presence (Staples 1995; Mowat et al. 2000). Minor vegetation effects could occur where heavy equipment is used, but this would be limited in extent and would not reduce vegetation foods for snowshoe hare and other lynx prey species. Timing of the work would prevent disturbance to den sites.

Road construction and decommissioning: No temporary road construction is proposed in the LAUs. Other road actions are proposed in alternative 2, and would result in temporary noise and human presence in the short-term, during implementation. Disturbance could occur, but lynx do not appear to be particularly sensitive to human presence (Staples 1995; Mowat et al. 2000), nor to avoid roads (Ruggiero et al.1999; McKelvey et al. 2000; Ruediger et al. 2000; Kolbe et al. 2007; Squires et al. 2010). Squires et al. (2010) reported that lynx denned further from roads than random expectation but did not think that was related to human disturbance, but rather related to fewer roads in the mature forests.

Roads are a source of mortality for lynx (Ferreras et al. 1991; Kramer-Schadt et al. 2004). Lynx are also vulnerable to overexploitation from trapping (Bailey 1936). Access for trapping is increased by the presence of roads and trails. However, lynx are a threatened species, and no legal trapping is allowed.

The only road actions would occur in the lynx habitat within the LAUs are decommissioning of already closed roads. These actions would result in reduced potential for disturbance to lynx prey.

Overall, considering all project components, there would be a minor (because it involves only 55 acres in boreal forest), short- to medium term, beneficial effect to lynx habitat, because hare forage would increase.

Summary of Effects of Lynx: Alternative 2 may affect, but is not likely to adversely affect lynx. Treatments are very limited in the mapped lynx habitat (55 acres), and would increase understory growth that provides cover and forage for prey species.

For lynx as MIS: This alternative would slightly improve conditions for lynx in the project area. The project would not contribute to a negative trend in viability on the Forest.

Critical Habitat for Lynx: Approximately 2,137 acres would receive silvicultural or fuels reduction treatments with implementation of Alternative 2. Overstory and understory treatments in critical habitat are displayed in Figure 73 and Figure 74. See Appendix A for treatment definitions.

Figure 73. Overstory Treatments in Lynx Critical Habitat

Overstory Treatments in Critical Habitat	
	Acres
Aspen	80
Dry forest/mistletoe sanitation	112
Dry forest restoration	11
Moist forest thin	15

Regeneration	19
Total	***236***

Figure 74. Understory Treatments in Lynx Critical Habitat

Understory Treatments in Critical Habitat	
	Acres
Aspen treatment: understory thinning	26
Aspen treatment: girdling	8
Ladder fuel reduction (LFR)	1,663
Timber stand improvement (TSI)	421
Whip-felling	19
Total	***2,137***

Most treatments are not in the mapped lynx habitat zone. Treatments in lynx habitat are discussed above, in the "Lynx" section. The mapped lynx habitat has the best potential for lynx use and use has been documented. The critical habitat designation also includes some areas that have been mapped as cool/dry or cool/cold mesic habitat. Treatments that are not in the mapped lynx habitat but are in a cool/dry or cool/cold habitat type that could have some boreal forest types, are as follows:

Figure 75. Overstory Treatments in Cool/dry and Cool/cold mesic Zones

Overstory treatments in Cool/dry and Cool/cold mesic zones Outside of Mapped Lynx Habitat	
	Acres
Aspen	21
Dry forest/mistletoe sanitation	18
Moist forest thin	15
Regeneration	1
Total	***55***

Figure 76. Understory Treatments in Cool/dry and Cool/cold mesic Zones

Understory treatments in Cool/dry and Cool/cold mesic zones Outside of Mapped Lynx Habitat	
	Acres
Aspen treatment: understory thinning	21
Ladder fuel reduction	915
Timber stand improvement	277

Whip-felling	1
Total	***1,214***

Silviculture treatments (overstory): Silvicultural treatments would open the canopy and result in increased understory vegetation, which would be beneficial to hares and other lynx prey. This would continue until the overstory closes again. Depending on how open the stands are post-treatment, this effect could last for a decade or more. This would still be a minor improvement in understory vegetation, since only 37 acres would be thinned in the potential habitat. The dry forest/mistletoe sanitation treatment occurs, as the name suggests, in drier forest types.

Fuels and understory treatments: Ladder fuel reduction and whip-felling could affect understory structure and reduce food availability for hares. Shrubs are not cut in these treatments, but small trees could provide some food resources for hares and other prey, although many trees are suppressed and lacking branches, or branches are too high for hares to reach. Timber stand improvement stands are plantations, provide limited cover, and have grown out of reach of hares. That leaves about 937 acres of thinning that could result in some browse loss for hares, distributed across the cool/dry and cool/cold mesic zones, in about 12 individual polygons. A general mitigation in fuels treatments is to leave unthinned patches of trees from 0.1 to multiple acres and to retain the complex patches, clumpiness and gaps retained in the harvest units. This will provide cover and forage for hares. Because understory vegetation is not limited across the critical habitat unit, the treatments are not expected to reduce hare forage or populations. Prey for lynx in this marginal habitat would be maintained.

Road actions: Approximately 0.04 miles of temporary road would be built in critical habitat, and result in a minor amount of vegetation loss. Approximately 0.3 miles of open road and 6.6 miles of closed road would be decommissioned. No closed roads would be opened. These actions would have minimal effects on vegetation, depending on how long the roads have been closed and other factors. Decommissioned roads may revegetate in the long-term to provide some habitat for lynx or their prey.

Other actions: No soil treatments or wetland thinning is planned in critical habitat. Fisheries projects- coarse wood placement in streams and culverts of stream crossings, would occur. These projects would not change vegetation or effect critical habitat.

Overall, considering all project components, there would be a minor (because it involves only 55 acres in boreal forest), short- to medium term, beneficial effect to critical habitat, because hare forage would increase.

Overall, considering all project components, there would be a, short- to medium term, beneficial effect to lynx habitat, because hare forage would increase.

Summary of effects on Lynx Critical Habitat: Alternative 2 may affect, but is not likely to adversely affect critical habitat for lynx. Only 55 acres of treatment would occur within the boreal forest area mapped as lynx habitat. These stands have grown out of reach of hares and are no longer providing a food resource. All overstory treatments would result in more open habitat that

will generate browse for hares, an important prey item for lynx. Alternative 2 is consistent with the LCAS. In the remainder of the critical habitat, treatments would not result in large-scale loss of understory vegetation in boreal forest. The area is mostly **not** boreal forest, and treatments in the cooler, moister types are limited and dispersed across the area.

Resource Indicator: Change to Habitat for Sensitive Species
Northern Goshawk:
Surveys for goshawks were limited and no territories were identified. If nests are located prior to contract award, the nest territory would be protected. If found during contract activities, timing restrictions would protect the active nest.

Silvicultural and fuel treatments: Treatments that open the overstory would make the stands less suitable for use by goshawks for nesting in the short-term. Foraging use may still occur, and opening the stands would create structural diversity and a potential increase in prey availability and diversity. Loss of snags as danger trees during logging would occur.

Ladder fuel reductions (LFR) would benefit goshawks by reducing understory density and reducing risk of fire and insect activity which could destroy nest stands and post-fledgling areas. LFR would remove a smaller size class of trees than the commercial thinning, which would result in little opening of the canopy. Loss of snags used for nesting or prey habitat would also occur. Timber stand improvement (TSI) thinning would occur in plantations of small trees that are not providing habitat for goshawks or prey. In the longer term, thinning would increase structural diversity and diversify prey habitat across the stand, and accelerate growth into larger trees that may become habitat for goshawks. Underburning would result in some loss of snags and large down wood, particularly soft snags, although some hard small snags would also be produced. The proposed actions would move stand structures toward mature and old forest structure, provide a variety of canopy closures and stand conditions, and result in a less uniform horizontal structure across the landscape, and would potentially improve habitat conditions for goshawks and their prey in the long-term over the current condition.

Riparian habitat with dense deciduous vegetation that would provide habitat for important prey items such as ruffed grouse and hares would be retained by use of riparian buffers. Some canopy opening through fuels treatments would stimulate deciduous vegetation that would improve habitat quality for grouse. In addition, aspen treatments would occur on 286 acres (66% of the deciduous habitat) and would retard the encroachment of conifer species on the aspen stands, which will perpetuate and increase the size of the aspen stands.

Reynolds et al. (1992) and Squires and Reynolds (1997) recommended prescribed fire and thinning from below to achieve non-uniform spacing of trees, with a maximum of 30-50% canopy opening, to sustain habitat for the northern goshawk and their prey. However, these recommended canopy closures are higher than historical conditions for the dry forest, and would preclude thinning and harvest options. Retention of clumps, patches, and riparian buffers, would result in denser conditions that would help to mitigate the overall reduction of overstory canopy. This is a component of the silvicultural prescriptions.

Post-harvest, assuming all overstory treatments result in open canopies that would not support nesting goshawks in the short-term, approximately 34% of the landscape would remain as potential habitat for goshawks. This is a 4% loss of habitat across the project area. Nest habitat does not appear to be a limiting factor in this landscape, and the proposed treatments would increase prey diversity and availability, accelerate growth into better habitat, and help to protect current habitat from fire, while protecting and retaining the largest size class trees.

Road actions: Approximately 0.2 miles of temporary road would be built in goshawk habitat. This could remove a small amount of habitat, a maximum of 0.7 acre, if all the area is timbered. Approximately 34% of the analysis area would still be habitat. Public access would not be permitted on temporary roads, so they would not increase access for falconers. Other road actions would not produce measurable change in vegetation. Decommissioning of currently open roads would occur on 1.6 miles in goshawk habitat, which would access for falconers. However, 1.9 miles of closed road would be reopened for public use, so a net increase in access of 0.3 miles would occur.

Other projects: None of the other project proposals would result in measurable changes to vegetation in goshawk habitat.

All proposed projects have the potential to disturb nesting goshawks that have not been detected. If territorial goshawks are observed, a biologist would attempt to locate the nest site, and timing restrictions would be imposed.

Overall, considering all project components, there would be minor, mixed, short- to long-term effects to goshawk habitat. About 4% of the habitat would be treated.

Summary of Effects on Northern Goshawk: Alternative 2 may impact individuals or habitat, but will not likely contribute to a trend towards federal listing or cause a loss of viability to the population or species. Habitat would be reduced by 1,510 acres, 4% of the analysis area. Approximately 11,712 acres would remain as potential habitat. A net increase in access of 0.3 miles of roads would occur, which could increase access for falconers, as well as increase disturbance from noise and human access.

Gray Flycatcher:
Silvicultural treatments would occur in 1,962 acres (9%) of the potential gray flycatcher habitat.

The proposed treatments (harvest, thinning, ladder fuel reduction, prescribed fire) would result in more open habitats across the project area. Post-harvest stand level canopy cover is expected to be above 25%, with the exception of the regeneration harvests on 79 acres, (approximately 0.4% of the project area), which are predicted to be 10%. However, to provide for a diversity of habitat types and species, prescriptions would emphasize clumps and gaps, so areas <10% and >70% canopy closure would be present, post-project. Fuels treatment units would retain 20% of the area in an untreated condition, to provide hiding cover and thermal cover for deer, and to meet habitat needs of gray flycatchers and other species.

Research suggests that thinning and burning in dry forest have few detrimental effects on native understory vegetation, and that the understory is largely unchanged several years after the

treatment (USDA 2012a). In the short-term, stand-level shrub cover would be changed by prescribed burning, and effects from prescribed burning are expected to be patchy. Shrub cover would be reduced in small areas of heavy fuel loadings, but overall effects of the prescribed burning are expected to be low-severity. Some loss of shrub component would occur during underburning, but abundant shrub cover would remain to provide habitat for this species. In the longer term, burning would increase the amount and quality of shrub habitat.

Thinning of the densely canopied stands would improve habitat for gray flycatchers. These heavily-stocked stands are not currently good habitat. Thinning would reduce stand density and open the canopy, possibly enough to produce an understory component of shrubs that may provide nest or forage habitat and would increase overall understory richness.

Because the treatments would result in patchy effects, it is difficult to predict how much habitat would be improved for gray flycatchers as a result of treatments. However, approximately 1,882 acres of hot dry or warm dry environmental types are proposed for treatments that would potentially result in conditions that are not too open or too densely canopied for gray flycatcher use. This is about 9% of the total hot dry/warm dry environmental type in the project area.

Harvest, thinning, burning and treatment of ladder fuels could have a short-term disturbance effect, but would reduce fuel loadings to protect remaining habitat. Abundant structure for nests and foraging would remain across the lower elevations used by gray flycatchers.

Road actions: There would be a net increase of 1.2 miles of open roads during project implementation, and 6.1 miles post-project in this habitat type, which could affect flycatchers.

Other projects: None of the other project proposals would result in measurable changes to vegetation in hot dry or warm dry vegetation types.

All proposed projects have the potential to disturb nesting birds, if the project occurs during that time.

Summary of Effects on Gray Flycatcher: Overall, considering all project components, there would be minor, negative, short-term effects to gray flycatcher habitat due to activity disturbance, minor amounts of shrub loss, and increased road densities during the project. There would be a long-term, moderate, beneficial effect on 9% of the habitat, due to creation of more open habitat types and reduced fuel loadings/fire risk, and a minor adverse effect due to increases in open roads.

Alternative 2 may impact individuals or habitat, but will not likely contribute to a trend towards federal listing or cause a loss of viability to the population or species. Vegetation treatments would have a beneficial impact on gray flycatchers. The project would reduce stand densities and increase availability and quality of shrub habitat. However, a small net increase in open roads in this habitat type could have a long-term negative effect. Because these roads are not heavily used, this negative effect would likely be minor. Mechanical treatments could also cause a short-term disturbance effect.

White-headed woodpecker:
Thinning and burning in dry forest stands would improve habitat for the white-headed woodpeckers by reducing competition and ladder fuels around large pines, which would accelerate development of large trees and increase the availability of seeds. Trees larger than 21" DBH would generally not be cut and would remain on the landscape to provide foraging habitat and, in time, large snags for nesting. The harvest treatments would provide additional stumps for nesting.

Because the treatments would result in patchy effects, it is difficult to predict how much habitat would be improved for white-headed woodpeckers. However, 1,882 acres (9% of the total hot dry/warm dry environmental type) are proposed for treatments that would potentially result in improved conditions for white-headed woodpecker use.

Harvest, thinning, burning and treatment of ladder fuels could have a short-term disturbance effect, but would reduce fuel loadings to protect remaining habitat.

Road Actions: Opening of 2.4 miles of currently closed roads in potential habitat would lead to snag loss on as much as 116 acres. This would reduce nesting and foraging habitat for white-headed woodpeckers. Approximately 2.2 miles of currently open roads would be decommissioned, which would offset the potential snag loss on a maximum of 107 acres.

Other projects: None of the other project proposals would result in measurable changes to vegetation in hot dry or warm dry vegetation types.

All proposed projects have the potential to disturb nesting birds, if the project occurs during that timeframe.

Summary of Effects on White-headed woodpecker: Overall, considering all project components, there would be a moderate (9% of the habitat), long-term beneficial effect from vegetation treatments and a minor, long-term adverse effect on snag habitat.

Alternative 2 may impact individuals or habitat, but will not likely contribute to a trend towards federal listing or cause a loss of viability to the population or species. Vegetation treatments would have a beneficial impact on white-headed woodpeckers. Tree growth would be accelerated by removal of competing smaller trees, and potential for large-scale habitat loss through high-severity wildfire would be reduced. However, a net increase of 0.2 miles of open roads would result in loss of snags on about 9 acres. Overall, the proposed project would improve conditions for white-headed woodpeckers in the project area and would not contribute to a negative trend in Forest-wide viability.

Western Gray Squirrels:
Silviculture and fuels treatments: Effects from harvest and fuels treatments on gray squirrels are mixed. Harvest and fuels treatments may result in loss of nests and potential nest sites (generally trees >15.8" DBH), would fragment the tree canopy that squirrels use for travel and escape cover, and would reduce abundance of fungi foods. Nest site loss is expected to be minimal because trees > 21" would rarely be cut, and known natal nests would be protected. Thinning prescriptions would provide for retention of clumps of trees, which would provide

opportunity for arboreal travel. Some loss of cavity habitat that would provide potential nest sites would occur with harvest and burning. Because nests are usually in the larger size class trees, it is unlikely that noncommercial or ladder fuel reduction thinnings would affect nests.

Underburning would remove some surface fuel which may reduce escape cover for squirrels moving along the ground. However, burning is generally patchy and larger down wood is not generally consumed. Thinning would increase food resources by accelerating growth of large ponderosa pines, which produce more pine seeds than small trees (Linders and Stinson 2007), and also by opening of the tree canopy, which would allow the development of a shrub understory and additional foods. All fuels treatments would help to protect occupied and potential gray squirrel habitat from effects of uncharacteristic wildfire.

Road actions: Approximately 1.2 miles of temporary road would be opened for logging use and could result in additional mortality from vehicle strikes due to logging traffic. Temporary road construction would result in a maximum loss of vegetation of 4.1 acres, which would reduce availability of cover and potential for arboreal travel. Post-harvest, open road decommissioning would occur on 2.2 miles in western gray squirrel habitat. However, other road changes would result in a net increase of 6.2 miles of open roads in this habitat post-project including 2.4 miles of currently closed road that would be opened to general use.

Other projects: None of the other project proposals would result in measurable changes to vegetation in hot dry or warm dry vegetation types.

All proposed projects have the potential to disturb squirrels. This would be a short-term effect during project implementation.

Overall, considering all project components, there would be moderate (30% of habitat affected), mixed effects to western gray squirrels in the long-term.

Summary of effects on Western Gray Squirrels: Alternative 2 may adversely impact individuals through loss of arboreal travel opportunities or nests and potential for mortality from vehicle strikes during logging, but is not likely to result in a loss of viability in the project area, nor cause a trend toward federal listing. Effects would occur on 10,256 acres, about 30% of the project area. Post-project, open road mileage would increase, increasing risk of mortality from vehicle strikes. Alternative 2 would decrease the risk of large-scale habitat loss from wildfire.

Resource Indicator: Habitat for Management Indicator Species
Spotted Owls- see above for discussion.

Winter Range for Mule Deer:
Silvicultural and fuels treatments: There are approximately 1,022 acres in harvest units and 3,231 acres of ladder fuel reduction treatments (without overstory treatment) that would occur on deer winter ranges. Approximately 557 acres, in 12 units would be logged during the winter in the Libby MA14 block. No winter activities are proposed in the Buttermilk MA14 block, or in any of the MA 26.

The proposed action would reduce thermal cover and increase forage for mule deer. The table below displays the cover remaining after treatments, and was modeled assuming that the harvest treatments would remove all thermal cover within the unit. The assumption for the LFR

units (outside of the harvest areas) was that approximately ½ of the seedling/sapling and post/pole-size component within the unit would be removed in the ladder fuel reduction treatments.

Figure 77. Estimated Post-treatment Thermal Cover, before mitigation

Alternative 2						
Management Area	***Winter thermal cover***		***Snow-intercept thermal cover***		***total***	
	acres	*%*	*acres*	*%*	*acres*	*%*
MA-14	2,611	24%	1,054	10%	3,665	33%
MA-26	200	17%	185	16%	385	33%

The total cover remaining across the winter range would be approximately 33% in each management area. To mitigate cover post-treatment levels below Forest Plan standards, and to provide for adequate cover distribution across the project area (and to increase diversity and provide connectivity and habitat elements for other wildlife species), each ladder fuel reduction unit would leave 20% of the area untreated, in patches from 0.1 acre to multiple acres in size.

The canopy reduction from harvest and fuel treatments would result in an increase in forage species. Underburning would also result in increases in availability and palatability of forage species, as the older woody vegetation is burned and new vegetation growth is stimulated. However, it is important that patches of dense cover of at least 0.1 acres be retained to provide hiding cover for mule deer (Germaine et al. 2004). In addition, the treatments would contribute to the sustainability of thermal cover and other vegetation on the landscape by promoting low-intensity wildfire behavior with less canopy fire. Treatments would maintain and restore stand structure, composition, and arrangement that would be less susceptible to stand-replacing wildfires that could extensively damage and reduce vegetation (including thermal cover) on the landscape.

Disturbance could occur as a result of winter logging, and deer may be temporarily displaced from the area being logged. The Forest winter range is higher elevation than the more heavily used areas on private land that are lower elevation and have less snow. Winter logging standards call for frozen ground and a minimum snowpack of 8“of compacted snow, to protect soils. By the time this amount of snow has accumulated, deer have often moved to lower elevations where food is more available. Anecdotal information suggests that deer may remain in units being logged in the winter to forage on lichens and fir needles from logged trees.

Road actions: Approximately 1.2 miles of temporary road would be constructed in winter range, open for logging use, then decommissioned. This would result in minor loss of vegetation for the short-term (less than 5 acres) until the vegetation regrows. Shrub species that may provide browse for deer may grow back within 5 years of decommissioning. Approximately 0.03 mile of closed road would reopen to general use on winter range, however the roads would still be closed by conditions during the winter period.

Decommissioning of currently open roads would occur on 2.2 miles. In the short and longer term, decommissioning of open roads would reduce access disturbance to deer, mortality from

collisions, hunting and poaching and avoidance of habitat. Eventually, vegetation would regrow and provide additional browse.

Other actions: Other proposed projects would cause short-term, temporary disturbance to deer during project implementation, but involve only minor vegetation change. No measurable changes to cover or forage for deer are expected.

Overall, considering all project components, there would be moderate (occurring on 8% of the winter range) short- to long-term mixed effects on winter range for mule deer. Forage would be increased in the short and longer term, but cover would be reduced, although adequate cover would still remain. Road decommissioning on winter range would be a minor, long-term beneficial effect.

Lynx- see discussion above.

Resource Indicator: Change to Habitat for Landbirds
The effects of forest restoration treatments on landbirds have been studied in several research projects. Gaines et al. (2007) found that dry forest restoration treatments implemented using the range of variation to guide forest thinning and burning, increased overall avian density and the overall density of neotropical migrants. There were positive density responses from several species that have been identified as species important to managers, including white-headed woodpeckers (which were only found in the treated stands) and chipping sparrows. Their results suggested that two aspects of the restoration treatments were important contributors to positive species responses: retention of the large tree component and creation of a more open overstory canopy.

Bagne and Purcell (2011) found that low-severity prescribed fires applied in spring served to drive the bird community towards pre-suppression conditions. Positive effects were found for riparian associate species, aerial foragers, and bark foragers.

Prescribed fire reduces populations of ground and shrub nesting birds (Wilson et al. 1995; Artman et al. 2001; Blake 2005), while benefiting populations of woodpeckers (Blake 2005; Russell et al. 2009) and species that forage in the air and on the ground (Saab et al. 2007; Russell et al. 2009).

Fuel reduction treatments that change stand structure or composition would cause some species to gain habitat and others to lose (Lehmkuhl et al. 2007). **Figure 78** displays the expected effects for these focal species.

Figure 78. Summary of habitat conditions and effects from fuels and vegetation treatments

Species	Direct and Indirect Effects	Conclusion
Chipping sparrow (focal species for open understory)	Stands would become more open with more ground foraging opportunities on approximately 39% of the pine habitat in the project area.	Beneficial effect for chipping sparrow.
Flammulated owl (focal species for large snags)	Bigger trees over time and reduced potential for fire loss would improve habitat on about 39% of the pine habitat in the project area.	Beneficial effect for Flammulated owls. Combination of leave areas and thinning create improved habitat in dry forest.

Varied thrush (focal species for structural diversity)	Stand structure would become more open and have fewer canopy layers as a result of treatments, over 14% of the habitat type. Mitigations of retaining 20% of fuels units in clumps and patches would retain habitat for the species.	Treatments would reduce habitat suitability for varied thrushes, but retained clumps and patches, and riparian buffers would leave a minimum of 20% of the area untreated. 86% of the mixed conifer habitat in the project area would remain in the current condition.
Brown creepers	Bigger trees over time and reduced potential for fire loss would improve habitat on about 39% of the mixed conifer in the project area.	Beneficial effect for brown creepers.
Ruffed grouse	Approximately 286 acres of aspen habitat would be maintained by removal of encroaching small conifers and girdling of large conifers that are shading the aspen stands. This would allow stands to grow larger.	Beneficial effect for ruffed grouse.
Yellow warbler and willow flycatcher	Limited treatments would occur in riparian habitats that would affect vegetation. Some fuel treatments and harvest would occur at the outer edges of the riparian reserves, and could result in increases in availability of shrub habitat, reduce susceptibility to fire and accelerate growth of large trees. 58 acres of dry forest thinning, 86 acres of TSI, 462 acres of LFR and 22 acres of wetland thinning would occur in the riparian. Wetland thinning would retard conifer encroachment.	Possible slight benefit for yellow warbler and willow flycatcher.

Other proposed actions would result in short-term disturbance. Riparian projects would improve riparian habitat conditions and reduce disturbance in the long-term.

Overall, there would be a moderate, long-term beneficial effect for species utilizing more open conditions and a moderate, long-term adverse effect for species preferring higher canopy closures and denser stand conditions.

3.7.4.3.2 Cumulative Effects

Spatial boundary: The geographic boundary is the project area, unless otherwise stated. The two drainages are sufficient in size to address effects to most species. Lynx geographic boundaries are the LAUs, and critical habitat. For deer and winter range, the geographic area is the winter range in the project area.

Temporal boundary: The temporal boundary is the last 100 years, since fire suppression began in the National Forests, to 20-40 years into the future, when the project's effects to vegetation would no longer be in evidence.

Past Actions: Fire-suppression and preferential logging of large trees have changed the character of forested stands from open, single-storied patches of large pioneer species, to dense multi-storied stands. This has led to a loss of structural and compositional heterogeneity and a predominance of young dense and relatively homogenous forest (Knapp et al. 2013). It has also led to accumulation and continuity of forest fuels which have contributed to large and more severe wildfires, which are projected to become even more common as the climate continues to warm (Westering et al. 2006). Fewer large snags occur compared to historical conditions, due to loss of large trees (fewer to become snags and down wood), firewood cutting and danger tree cutting. Road construction has resulted in habitat loss and increased access,

which increases potential for disturbance, habitat avoidance, loss of snags through firewood cutting and danger tree management, mortality from collisions, hunting/poaching, trapping, and collecting.

On-going Actions: Fire-suppression, danger tree cutting and firewood cutting are on-going in the project area, contributing to increases in stand densities and loss of snags. Road maintenance, weed treatments, and grazing are also occurring. Road maintenance and weed treatments may add noise disturbance. Grazing may alter vegetation, reducing the grass/forb component and reducing competition around small trees.

Reasonably Foreseeable Future Actions: No future vegetation projects have been identified.

3.7.4.3.5 Summary of Cumulative Effects

Past actions have resulted in denser forest conditions, with fewer snags and large trees, and increased access to the project area.

The Travel Management decision will reduce access by motorized vehicles and the associated disturbance and habitat avoidance.

The following indicators would have a measurable change in cumulative effects:

Spotted owls and goshawks: On-going firewood cutting is reducing snags that provide nesting structures and habitat for prey for both owls and goshawks. Proposed road decommissioning will reduce this effect. The cumulative effect is that the area is less suitable for owls, but probably neutral for goshawks, since abundant dense habitat will remain.

Landbirds: Snag levels have been reduced by firewood cutting. Loss of snags and large trees and denser, more uniform forest structure has reduced habitat quality for flammulated owls and chipping sparrows. The proposed actions would open the stands on about 39% of the project area, counteracting this effect on 8,426 acres. This would improve habitat for chipping sparrows and flammulated owls. However, a net increase in open roads would occur, and result in additional snag loss. Travel management does not affect snag levels and firewood cutting, thus there is no overlap in effects for snag-associated species. Travel management could improve riparian habitats, by closing them to off-road motorized use.

3.7.4.4 Alternative 3 – Effects Unique to Alternative 3

3.7.4.4.1 Effects

See Alternative 2 for effects of vegetation treatments. These are the same for both alternatives.

All other projects except for rock armoring and road actions would be the same as in Alternative 2.

Rock armoring would occur in Alternatives 2 and 3 as a mitigation at six perennial stream crossings used for summer haul routes in Libby Creek, and at several other locations only in Alternative 3, and would potentially cause noise disturbance, which would be short-term in nature. Vegetation effects would minimal. No substantial effects to any wildlife species are expected, and these will not be discussed further.

Across the analysis area, the following road actions would occur in Alternative 3:

- Temporary road construction 1.2 miles
- Decommissioning of open roads 6.1 miles
- Decommissioning of closed roads 51.0 miles

These actions would have a net beneficial effect for wildlife. Fewer roads mean less access for firewood harvest, hunting, trapping, poaching and collecting, reduced avoidance of suitable habitat and less disturbance from motorized vehicles and human presence. As vegetation returns to the roadbed, additional forage and cover would be produced. Short-term disturbance would occur during decommissioning and road construction. Road construction would remove 4.1 acres of habitat across the project area.

In general, Alternative 3 would have more beneficial effects to wildlife in the long-term than Alternative 2. The wildlife resource indicators that would change for Alternative 3 are discussed below.

Figure 79. Resource Indicators and Measures for Alternative 3 (Road actions only)

Resource Element	Resource Indicator	Measure	Alternative 3
Habitat for threatened species- spotted owls, lynx, and Critical Habitat (CH) for lynx.	Suitable Spotted Owl Habitat (late old successional habitat)	Open roads in NRF	12.7 post-project
	Suitable Lynx habitat in LAUs	Open roads in habitat-mi.	2.6 mi. post-project
	Critical Habitat for lynx	Open roads in habitat	9.8 miles post-project
Habitat for sensitive/focal species- goshawk, gray flycatcher, white-headed woodpecker and western gray squirrel.	Suitable habitat- goshawks	Open roads in habitat	28.0 post-project
	Suitable habitat- gray flycatcher, white-headed woodpecker, and western gray squirrel	Open roads in habitat	34.5 post-project
Habitat for MIS, winter range, mule deer	Winter range	Open roads in habitat	12.2 post-project

Resource Indicator: Changes to Habitat for Threatened Species
Spotted Owls: No temporary roads would be built in suitable (NRF) habitat. Approximately 1.4 miles of roads would be decommissioned in suitable habitat, which could result in short-term

disturbance to owls. Only one segment is a currently open road, 0.03 miles. The other roads are closed and in various stages of revegetation. Approximately 0.9 miles of closed road would be reopened for administrative access, which is generally infrequent. Habitat concentrations have been surveyed, with no responses from spotted owls. It is unlikely that the analysis area has sufficient habitat to support owls currently. A long-term benefit would occur, as decommissioned roads would eventually revegetate, possibly providing additional foraging habitat in 20 years or more.

Overall, considering all project components (vegetation, aquatics and roads), the project would have minor (to NRF habitat) to moderate (dispersal habitat) short-term to medium-term (1-10 years), mixed effects for habitat, and long-term moderate beneficial effects (because fire/insect activity risk would be reduced across landscape, and stands would be more likely to have large tree habitat suitable for owls). There is currently not enough habitat in the project area to support owls.

Alternative 3 may affect, but is not likely to adversely affect spotted owls. The area does not have enough habitat to support nesting owls currently. No roads would be built in suitable habitat, but 1.4 miles of open roads would be decommissioned, which would reduce disturbance to owls. Surveys of the habitat concentrations have not elicited responses from spotted owls.

Lynx and Critical Habitat: No temporary roads would be constructed in lynx habitat. Approximately 0.6 mile of closed road would be reopened for public use, and 1.5 miles for administrative use. Approximately 2.6 miles of currently closed roads would be decommissioned with implementation of Alternative 3. This would probably have a minimal effect on lynx, as they are not particularly disturbed by human presence, are not hunted or trapped (since they are a sensitive species) and with one exception near Buttermilk Butte, these roads are not likely to receive much OHV use due to vegetation, length, and lack of interesting destination. In the long term, decommissioned roads will revegetate, producing forage and cover for prey species. This would be a minor effect on about 9 acres, from about 5 years after decommissioning, if roads are not already vegetated and will be ripped or subsoiled, to 30 or 40 years or more, when tree species would grow out of reach by hares.

Temporary avoidance of the sites could occur during implementation.

In critical habitat, 0.04 miles of temporary road would be constructed, and 1.6 miles of open road would be decommissioned. Temporary road construction would remove less than 1 acre of habitat. Decommissioning would result in revegetation over time, which could provide more cover and forage for hares and other prey on less than 6 acres. This is a minor effect covering only 0.05% of the critical habitat. No closed roads would be reopened.

Overall, considering all project components, there would be a short- to medium term, beneficial effect to lynx habitat and critical habitat, because hare forage would increase.

Alternative 3 may affect lynx (due to short-term disturbance to prey) but is not likely to adversely affect lynx. Den sites are not likely to be disturbed, as sites (both road decommissioning and

vegetation treatment units) are generally not accessible during the early season when denning occurs.

Resource Indicator: Change to Habitat for Sensitive Species
Northern Goshawks: Open roads provide access for falconers, which may result in loss of nestlings. Alternative 3 would decommission 4.1 miles of currently open road, which would make access more difficult.

Overall, considering all project components, there would be minor, mixed, short- to long-term effects to goshawk habitat. About 4% of the habitat would be treated. Additional road decommissioning in alternative 3 (compared to alternative 2) would result in a long-term, moderate, beneficial effect for goshawk habitat.

Gray flycatchers: Open roads may affect gray flycatchers. However, no specific information was found on the response of gray flycatchers to roads. Noise effects have been documented, but at much higher levels than would occur with use of forest roads.

Overall, considering all project components, there would be minor, negative, short-term effects to gray flycatcher habitat due to activity disturbance, minor amounts of shrub loss, and increased road densities during the project. There would be a long-term, moderate, beneficial effect on 9% of the habitat, due to creation of more open habitat types and reduced fuel loadings/fire risk, and a possible minor adverse effect due to increases in open roads.

Alternative 3 may adversely impact individuals, but is not likely to result in a loss of viability in the project area, nor cause a trend toward federal listing.

Western Gray Squirrel: Approximately 1.2 miles of temporary road would be constructed in habitat for gray squirrels, open for logging use, then decommissioned. This would result in increased potential for squirrel mortality from vehicle strikes and a minor loss of vegetation for the short-term (less than 5 acres) until the vegetation regrows. Shrub species that may provide cover or forage may grow back within 5 years of decommissioning.

Decommissioning of currently open roads would occur on 6.1 miles. In the short and longer term, decommissioning of open roads would reduce access and disturbance to squirrels, mortality from vehicle strikes, and avoidance of habitat. Eventually, vegetation would regrow and provide additional cover and forage. Disturbance to squirrels and avoidance of habitat could occur during decommissioning, but would be temporary and short-term. Approximately 0.1 mile of currently closed road would be opened, which would result in vehicle traffic and potential loss of squirrels through vehicle strikes.

Overall, considering all project components, there would be moderate (30% of habitat affected), mixed effects to western gray squirrels in the long-term.

Alternative 3 may adversely impact individuals through loss of arboreal travel opportunities or nests and potential for mortality from vehicle strikes during logging, but is not likely to result in a loss of viability in the project area, nor cause a trend toward federal listing. Effects would occur on 10,256 acres, about 30% of the project area. Post-project, open road mileage would

decrease, due to the decommissioning of roads. Alternative 3 would increase habitat resilience to severe, large-scale wildfire, protecting it into the future.

Resource Indicator: Habitat for Management Indicator Species
*Winter Range for Mule Deer***:** Approximately 1.2 miles of temporary road would be constructed in winter range, opened for logging use, and then decommissioned. This would result in minor loss of vegetation for the short-term (less than 5 acres) until the vegetation regrows. Shrub species that may provide browse for deer may grow back within 5 years of decommissioning. Deer may be displaced during use of the temporary roads. However, logging would occur in a limited area at any one time, and road use would be short-term. This would mitigate effects to deer.

Decommissioning of currently open roads would occur on 6.1 miles. In the short and longer term, decommissioning of open roads would reduce disturbance to deer, mortality from collisions, hunting and poaching and avoidance of habitat. Eventually, vegetation would regrow and provide additional browse. Disturbance to deer and avoidance of habitat could occur during decommissioning, but would be temporary and short-term.

Approximately 0.3 miles of closed road would be reopened, and could result in disturbance, displacement, access for hunting and potential for collisions with deer.

Overall, considering all project components, there would be moderate (occurring on 8% of the winter range) short- to long-term mixed effects on winter range for mule deer. Forage would be increased in the short and longer term, but cover would be reduced, although adequate cover would still remain. Road decommissioning on winter range would be a minor, long-term beneficial effect.

3.7.4.4.2 Cumulative Effects
There would be no additional cumulative effects for Alternative 3. Refer to Alternative 2 for a description of potential cumulative effects for the proposed actions.

3.7.4.4.5 Summary of Effects

Figure 80. Summary of wildlife resource indicators for all alternatives.

Resource Indicator	Existing Condition (Alternative 1)	Alternative 2	Alternative 3
Spotted Owl nesting, roosting, foraging (NRF) habitat	1,054 acres	1,022 acres (-3%)	1,022 acres (-3%)
Open road miles in nesting, roosting, foraging habitat	15.7 miles	15.8 during project 17.2 post project (0 temporary roads built, 0.3 miles decommissioned)	15.8 during project 17.2 post project (0 temporary roads built, 0.3 miles decommissioned)
Treatments in lynx habitat (early successional habitat in	Spirt Mountain – 0 acres Methow Gold – 0 acres	Spirt Mountain – 5 ac. (2% treated) Methow Gold – 50 ac. (41% treated)	Spirt Mountain – 5 acres (2% treated) Methow Gold – 50 acres (41% treated)

Resource Indicator	Existing Condition (Alternative 1)	Alternative 2	Alternative 3
the subalpine fir zone) in LAUs			
Open roads in lynx habitat in LAUs	2.6 miles	2.6 miles during project 2.6 miles post-project (0 miles temporary roads built, 0 miles decommissioned)	2.6 miles during project 2.6 miles post-project (0 miles temporary roads built,0 miles decommissioned)
Acres of treatment in designated critical habitat for lynx	0 acres	2,137 acres treated (17%)	2,137 acres treated (17%)
Open roads in critical habitat for lynx	9.9 miles	9.9 miles during project 15.7 miles post-project (.04 miles temporary roads built, 0.2 miles decommissioned)	9.9 miles during project 14.3 miles post-project (.04 miles temporary roads built, 1.6 miles decommissioned)
Goshawk suitable habitat (dense stands with large trees).	13,022 acres (38% of non-Wilderness project area)	11,712 acres (34% of non-Wilderness project area)	11,712 acres (34% of non-Wilderness project area)
Goshawk changes to suitable habitat (open road miles)	34.8 miles	35.2 miles during project 40.2 miles post-project (0.2 miles temporary road built, 1.6 miles decommissioned	35.2 miles during project 37.7 miles post-project (0.2 miles temporary road built, 4.1 miles decommissioned
Improvements in habitat for sensitive species-gray flycatcher, white-headed woodpecker, and western gray squirrel	0 acres	1,962 acres of potential habitat improved (9% of the habitat)	1,962 acres of potential habitat improved (9% of the habitat)
Miles of roads open in habitat for sensitive species-gray flycatcher, white-headed woodpecker, and western gray squirrel	45.3 miles total	46.5 miles during project 51.5 miles post-project (1.2 miles temporary roads built, 2.2 miles decommissioned)	46.5 miles during project 47.6 miles post-project (1.2 miles temporary roads built, 6.1 miles decommissioned)
MA 14 winter range cover: forage ratios.	52% cover (SIT = 22%, WT = 29%)	33% cover (SIT = 10%, WT = 24%)	33% cover (SIT = 10%, WT = 24%)
MA 26 winter range cover: forage ratios.	35% cover (SIT = 16%, WT = 19%	33% cover (SIT = 16%, WT = 17%)	33% cover (SIT = 16%, WT = 17%)
Open roads in MIS habitat for mature/old growth forest (spotted owls), winter ranger (mule deer) and lodgepole pine (lynx)	23.5 miles	23.8 miles during project 21.0 miles post-project (1.2 miles temporary road built, 1.1 miles decommissioned).	23.8 miles during project 16.0 miles post-project (1.2 miles temporary road built, 6.1 miles decommissioned).
Treatments in habitat for landbirds (pine, mixed conifer and deciduous/riparian habitats	Ponderosa Pine = 0 acres	8,426 acres treated (39%)	8,426 acres treated (39%)
	Mixed conifer = 0 acres	1,817 acres treated (14%)	1,817 acres treated (14%)
	Riparian = 0 acres	628 acres treated (plus 40 acres aspen) (20%)	

Resource Indicator	Existing Condition (Alternative 1)	Alternative 2	Alternative 3
	Deciduous (aspen)= 0 acres	286 acres	286 acres

Vegetation treatments are the same in both alternatives, and restore habitat conditions and reduce risk of high-severity disturbance on 6% of the project area through silvicultural treatments. Risk of fire is reduced on another 24% of the project area through fuels treatments.

It is likely that fire suppression resulted in better habitat for spotted owls than would have otherwise have existed in the area, because the forests became denser. However, past logging of large trees degraded that habitat. Currently, the project area does not have enough habitat to support owls. Suitable nesting, roosting, foraging habitat would be further degraded on 3% of the habitat, by thinning which would reduce canopy closures. Vegetation treatments would retain large trees, reduce ladder fuels to protect old growth structure, and set stands on a trajectory towards becoming dry forest old growth habitats, which are currently lacking compared to historical conditions. Treatments would also reduce the risk of losing these habitats to wildfire.

Lynx habitat comprises little of the project area, and early-successional stands providing hare forage would not be treated. Critical habitat for lynx comprises a much greater proportion of the project area, but is largely dry forest that won't contribute to boreal forest conditions. Treatments would occur over 17% of the critical habitat.

About 4% of the current goshawk habitat would be treated, with 34% remaining across the project area. Large trees would be retained, and understory stand densities would be reduced. Habitat diversity would result from the treatments and would provide prey habitat. Roads open to public use would increase by 0.4 miles, during project activities. Opening of 1.9 miles of closed roads to public use would occur would in alternative 2, post-activities, with a net open road increase of 5.4 miles which would provide more access for falconers than current conditions. Alternative 3 would reduce open roads by 6.8 miles and would protect goshawk nests better than alternative 2.

Habitat for western gray squirrels would be degraded by opening of the canopy, which could reduce arboreal travel. However, the habitat would be better protected from large-scale disturbance from wildfire, insects and disease spread. Roads would increase in alternative 2, increasing chance of mortality through vehicle strikes.

Habitat on mule deer winter range would experience moderate short- to long-term mixed effects, occurring on 8% of the winter range. Forage would be increased in the short and longer term, but cover would be reduced, although adequate cover would still remain. Post-treatment cover levels would be lower than Forest Plan standards and guidelines, however. To mitigate this, and to provide for adequate cover distribution across the project area, each ladder fuel reduction unit would leave 20% of the area untreated, in patches from 0.1 acre to multiple acres in size.

Since the time that the Forest Plan was written, studies have found that thermal cover is not as critical as forage quality and quantity for winter survival of ungulates (USDA 2012a). Population declines in the region have been attributed to reduced shrub diversity, declining productivity of aging shrubs and lack of recruitment of new shrubs due to fire suppression (Fitkin and Heinlen 2012, 2015), rather than thermal cover.

The Okanogan-Wenatchee Restoration Strategy suggests that emphasizing the reduction of road density and enhancement of forage, can allow reduction in thermal cover while meeting the intent of standards for deer winter ranges, to resolve the potential conflict between restoring forests and winter range thermal cover. Road decommissioning on winter range would be a long-term beneficial effect. Decommissioning of currently open roads would occur on 2.2 miles. Approximately 1.2 miles of temporary road would be constructed in winter range, open for logging use, then decommissioned. Disturbance could occur to deer on winter range and may result in displace from active units, but would be short-term in nature.

Landbirds using open stands and those using riparian habitats would be benefitted by vegetation and other non-road treatments. Treatments would improve habitat conditions for white-headed woodpeckers and gray flycatchers, both sensitive species preferring more open habitats. There would be less habitat for species using denser stands of small trees, such as the varied thrush. However, vegetation treatments occur on a small portion of the project area, about 1/3, and abundant dense habitat would remain over 2/3 of the area.

Alternative 3 reduces disturbance, habitat avoidance, access and related mortality to wildlife species compared to the current condition. Alternative 2 decommissions 2.3 miles of open roads and results in 66.1 miles of open roads (13.2 miles administrative use only). Alternative 3 decommissions 6.1 miles, and results in 44.7 miles of open roads (4.7 miles administrative use only) making Alternative 3 the more beneficial alternative to wildlife species.

3.7.5 Consistency Statement

Compliance with LRMP and Other Relevant Laws, Regulations, Policies and Plans
The action alternatives comply with Executive Order 13186 (because they restore habitat for migratory birds to more historical conditions with silvicultural, fuels and wetland treatments), Okanogan Forest Plan (with an amendment that would reduce deer winter thermal cover), Northwest Forest Plan (develops old-growth forest characteristics), Recovery Plan for Northern Spotted Owl (emphasizes vegetation management treatments outside of spotted owl core areas or high value habitat), the Forest Restoration Strategy (retains legacy structures while restoring spatial patterns and maintaining spotted owl habitat), and the Lynx Conservation Assessment and Strategy (does not cut current early successional stands that have hare forage value).

Forest Plan Amendment Effects on Substantive Provisions
To meet Purpose and Needs #2, #3, #4 and #6 identified in Chapter 1 of the EA, vegetation management through thinning would reduce deer winter range cover below Okanogan National Forest Land Resource Management Plan Standard and Guidelines MA14-6A and MA26-6A, requiring a project-specific amendment.

The justification for a reduction in deer winter cover is based on literature review that failed to find a need for 40% thermal cover and the landscape analysis for the project area that found an overabundance of dense stands. The best available science information (BASI) considered during the literature review includes Cook's 1996 and 1998 papers because they were cited in the Forest Restoration Strategy (USDA 2012a), which provides the BASI for forest restoration used in this project. Other literature also emphasized the importance of forage. A summary of BASI regarding deer thermal cover resulted in these findings:

- Cook et al. (1998) concluded that their findings, combined with those of other thermal cover studies (e.g., Robinson 1960; Freddy 1986), offered strong evidence that influences of thermal cover on animal performance and, by extension, population dynamics was rarely of consequence. Cook (in Duncan 2000) notes that "the finding that thermal cover failed to provide energetic benefits during winter is consistent with every other study of thermal cover influence on large ungulates conducted under rigorous scientific conditions", and supports the need for forage over a specific amount of cover, at least for elk, with four key findings:
    1. No significant positive effect of thermal cover was found on condition of elk during any of four winter-long experiments and two summer-long experiments. In fact, during winter, dense cover actually provided the most costly energetic environment.
    2. The lack of significant positive benefits of thermal cover during any winter of the study is consistent with every other study of thermal cover influences on large wild ungulates conducted under rigorous scientific conditions.
    3. During summer, results showed no indication that elk performance was influenced in any way by forest cover treatments, despite temperatures significantly above normal both summers. Other researchers have found elk to be surprisingly tolerant of high summer temperatures.
    4. The energetic benefits of thermal cover seem inconsequential, thus leaving forage effects as the primary mechanism through which habitat influences individual animal performance.
- Hobbs (1989) also found thermal cover to have negligible effects on deer during winter. Cook et al. (2005) noted that there are tradeoffs between providing dense forest cover and providing forage resources, and concluded that cover is needed where security is low or where snow accumulations are factors limiting animal performance. They reviewed four experiments on quantitative value of thermal cover on deer and elk, and concluded that the weather-moderating effects of thermal cover were probably insufficient to be of much biological value.
- Mysterud and Ostbye (1999) found that, although cover is important for habitat selection of temperate ungulates, there is no hard evidence that cover affects demography so much that it limits population growth in forested areas, and that there is no evidence that specific arrangements of food and cover areas confer any large advantage to deer.
- Coulombe et al. (2011) concluded that deer space use appeared to be based more strongly on forage biomass than on cover, particularly at higher population densities.

- Findings by Masse and Cote (2009) suggested that habitat selection by white-tail deer at high population densities and in the absence of predators, were driven by forage acquisition rather than a trade-off between forage and cover.
- Local studies of mule deer winter range use in Okanogan and Chelan counties found little use of dense cover stands. Naney and Myers (undated) followed 11 radio-collared deer and made 692 observations representing 1,044 deer in the Methow Valley during two winters. Of the deer observed, 73% were on sites with no conifer crown closure. Five percent of the total winter observations were of deer using cover with greater than 60% crown closure. Ninety percent of the winter range was dominated by habitat classes dominated by bitterbrush, sagebrush, bunchgrass, and pole-sized trees with undergrowth of shrubs or bunchgrass. In this study, deer did not appear to prefer thermal cover. However, they noted that observations were daylight hours only, and during winters that were warmer and drier than normal. Moore (2003), in a similar study in Chelan County, found that mule deer use was positively associated to areas without cover, and had a negative association to areas of cover. No difference in day and night habitat use was observed.
- Mule deer populations in Washington Department of Wildlife's Region 2, where the project is located, have experienced a gradual long-term decline in numbers which is attributed to reduced shrub diversity, declining productivity of aging shrubs and lack of recruitment of new shrubs due to fire suppression (Fitkin and Heinlen, 2012). Herd growth has plateaued, and productivity and recruitment has fallen off as the herd reached 20-25,000 animals, which appears to be the landscape carrying capacity for deer (ibid). Fitkin and Heinlen conclude that unless steps to revitalize shrub growth on winter range and human development is managed, this declining trend can be expected to continue. This project would increase forage on more than 2,000 acres of winter range, including the 746 acres as provided by the amendment, and move habitat conditions closer to historical characteristics that developed under natural disturbance regimes.
- During the public scoping period for this project, one commenter provided several references regarding deer cover. Two of these references have already been evaluated previously (Cook et al. 1998 and 2005). Of the remaining references, Forrester and Wittmer (2013) discussed population dynamics, but not thermal cover, and support the need for quality forage. Bender (2012) discusses mule deer habitats in arid and semi-arid habitats with very different plant associations (pinyon, juniper, oak-mountain mahogany, mesquite shrublands and others) than the winter range habitats dominated by ponderosa pine, mixed conifer, and open shrub-steppe habitats of bitterbrush, serviceberry and bluebunch wheatgrass that are used by the migratory mule deer population in north central Washington. The mule deer population in the Bender publication does not appear to be migratory. The percentages recommended in the Bender publication are not applicable.
- A more recent literature search (April, 2017) did not locate additional research on specific cover levels on either winter or other seasonal ranges; no references were found that indicated the need for 40% or more of the winter range to be in a cover condition.

The 2012 Planning Rule as amended (36 CFR 219) requires consideration of how the proposed Forest Plan amendment would affect substantive provisions identified in the Planning Rule. With respect to wildlife, the following substantive provisions would be affected by the proposed amendment:

219.8(a)(1)(i) Contributions of the plan area to ecological conditions within the broader landscape influenced by the plan area. Thinning would cause beneficial, short- to long-term, minor to moderate effects on ecological conditions within the broader landscape because it would reduce canopy closure and increase sunlight reaching the ground, resulting in an increase of forage available to mule deer and other wildlife species. Creating more forage contributes to a greater proportion of mule deer surviving winter conditions, which increases the sustainability of the migratory mule deer populations in the greater Methow Valley beyond the project area. Forage would be increased in the short and longer term, and cover would be reduced, but adequate cover would remain on more than 33% of the winter range. (Revised Preliminary EA at p.198-199).

219.9(a)(1) Ecosystem integrity. Thinning as provided by the amendment would have a beneficial, short- to long-term, minor to moderate effect on terrestrial ecosystems because thinning and associated prescribe fire treatments in deer winter range cover would maintain and restore stand structure, composition, and arrangement that would be less susceptible to stand-replacing wildfires that could extensively damage and reduce vegetation (including thermal cover) on the landscape (Revised Preliminary EA at p. 198-199).

219.9(a)(2)(i) Key characteristics associated with terrestrial ecosystem types. There would be a minor, long-term, beneficial effect from thinning as provided by the amendment (acceleration of growth of large trees which will become large snags) and a minor, long-term, adverse effect on snag habitat used by cavity excavators and other species (Revised Preliminary EA at p. 193-194) due to minor loss of snags as hazard trees in units. Thinning as provided by the amendment would create a beneficial, short- to long- term, minor effect on forage available for deer because thinning would open up the tree canopy and allow more sunlight and precipitation to reach the ground, resulting in more vegetation that provides more browse for deer (Revised Preliminary EA at p.198-199). Thinning would cause a slight reduction in habitat connectivity that overlaps with deer winter range cover as forested stands would become more open as a result of thinning, and would provide conditions more similar to historical conditions. The outcome on connectivity habitat would be mixed, with an adverse, short- to medium-term, minor effect on species that prefer more closed habitat, and a beneficial, short- to medium-term, minor effect on species that prefer more open habitat. With the exception of the 48 acres of units in deer winter range cover that would be thinned with the Variable Retention Regeneration prescription, most units would continue to provide forested connectivity because clumps of denser forest would be retained due to the marking method that would leave clumps of trees in commercial thinning units, and design criteria #77 for noncommercial thinning that would retain 20% of each unit in unthinned patches from 0.1 to multiple acres in units treated with the ladder fuel reduction prescription.

219.9(b) Additional species-specific plan components. The following federally-listed threatened or endangered species are in or have habitat within the project area, and would be affected by thinning as allowed by the amendment as follows:

- Wolves: Although gray wolves exist in the project area and could move through thinning units, no dens or rendezvous sites have been found in the units. Thinning may temporarily displace prey species (deer) (Glidden, 2017 and Biological Assessment). There would be minor short- to long-term beneficial effects on winter range for mule deer. Forage would be increased in the short and longer term, and cover would be reduced, although adequate cover would still remain on 33% of the winter range. (Revised Preliminary EA at p.198-199). There would be a negligible, short-term negative effect to wolves due to short-term displacement of prey, and short-to long-term, minor beneficial effects to wolves because forage for deer would be increased.
- Grizzly bear: The project area is in the North Cascades Grizzly Bear Recovery Zone. Habitat for grizzlies and a food source (deer, plants) occur across the area. No sightings of grizzly bears have been reported in the project area. Forage for bears and ungulate prey would improve in quality and quantity due to treatments, (Glidden, 2017 and project Biological Assessment). There would be a negligible, short-term, negative effect to bears due to short-term displacement of prey, and short-to long-term, minor beneficial effects to bears because forage for deer would be increased.
- Northern spotted owl: NRF habitat that overlaps within deer winter range cover would be slightly degraded by noncommercial treatment on 203 acres of NRF and by commercial thinning on 27 acres. Design features #72 & 73 for work in NRF stands would reduce negative effects to owl habitat while also reducing risk from wildfire, competition between trees, insects and disease, and would prevent downgrading the habitat. Mitigations include limiting diameter of large trees cut to smaller than 21" DBH in NRF stands, retaining snags and down logs, creating no openings larger than ¼ acre and maintaining canopy closures at 60% or more. The amendment would have adverse, short-term to medium-term, minor effects for spotted owl habitat due to the slight opening of the canopy. The amendment would have beneficial, short- to medium-term, minor effects for spotted owl habitat because thinning would reduce the risk of high-severity wildfire, which increases protection for the NRF habitat, and beneficial, long-term, minor effects because large-scale fire/insect activity risk would be reduced across landscape, and stands would be more likely to have large tree habitat suitable for owl. (Revised Preliminary EA at p. 187-188).
- Critical Habitat (CH) for Lynx: There are 740 acres of CH in winter range, which is 6% of the total CH in the project area. CH in winter range is isolated from the mapped lynx habitat and consists of some colder mesic forest surrounded by dry forest. Of the 12,890 acres of CH in the project, 203 acres would be treated with noncommercial thinning, primarily using the LFR thinning prescription (201 acres). The amendment would affect a maximum of 2% of the project CH. There would be a beneficial, short- to medium term, minor effect to critical habitat, because hare forage would increase (Revised Preliminary EA at p.192-193).

Region 6 Regional Forester Sensitive Species that would be affected by thinning as allowed by the amendment include gray flycatchers, white-headed woodpeckers, western gray squirrels, and Northern goshawk. Total habitat for gray flycatchers, white-headed woodpeckers, and western gray squirrels, modelled as the hot/dry and warm/dry habitat types, is 21,743 acres. Most of the winter range (93%) is habitat for these species. The amendment for deer winter cover affects 746 acres of the proposed thinning (commercial and non-commercial), which is 3% of the total habitat in the project area, assuming all the treatments are in this habitat and that all treatments would reduce cover. Thinning as allowed by the amendment would cause the following effects to these R6 Sensitive Species:

- Gray flycatchers: Thinning would cause adverse, minor, short-term effects to habitats for this species due to activity disturbance, minor short-term shrub loss, and increased road densities during the project and beneficial, long-term, minor effects due to creation of more open habitat types and reduced risk of habitat loss, and a negligible adverse effect due to increases in open roads. (Revised Preliminary EA at p. 195-196).
- White-headed woodpeckers: Thinning would cause an adverse, long-term, minor effect on snag habitat because some snags would be removed as hazard trees during project activities; however, the loss of these snags would be counterbalanced by the creation of some snags through expected mortality caused by prescribed burning. There would be a beneficial, long-term, minor effect from thinning treatments because thinning would accelerate the development of larger trees that would, in time, become larger snags for this species to use as habitat. (Revised Preliminary EA at p. 196-197).
- Western gray squirrel: Thinning would cause adverse, short- to medium-term, minor effects to western gray squirrels due to the loss of arboreal travel opportunities or nests, potential for mortality from vehicle strikes during logging, and reduced abundance of fungi foods. However, thinning would also cause beneficial, medium- to long-term, minor effects because thinning would increase food resources by accelerating growth of large ponderosa pines, which produce more pine seeds than small trees (Linders and Stinson 2007), and also by opening of the tree canopy, which would allow the development of a shrub understory and additional foods. Thinning would help to protect occupied and potential gray squirrel habitat from effects of uncharacteristic wildfire. (Revised Preliminary EA at p. 197-198).
- Northern Goshawk: There are about 13,022 acres of goshawk habitat in the project area and about 29% is in winter range. Thinning as allowed by the amendment would affect a maximum of 6% of the total habitat in the project area for this species, assuming all the treatments are in this habitat and that all treatments would reduce cover. There would be adverse, short- to long-term, minor effects to goshawk habitat as a result of the amendment because thinning that opens the overstory would make the stands less suitable for use by goshawks for nesting in the short-term, although foraging use would still occur. Some snag habitat used for species that may be prey items for goshawks, such as woodpeckers, would be removed as hazardous trees during commercial thinning operations. Beneficial, short- to long-term, minor effects from thinning include opening the stands, which would create structural diversity and a potential increase in prey availability and diversity. Understory thinning would benefit goshawks by reducing

understory density and reducing the risk of fire and insect activity which could destroy nest stands and post-fledgling areas. In the longer term, thinning would beneficially increase structural diversity and diversify prey habitat, and accelerate growth into larger trees that may become habitat for goshawks. Riparian habitat with dense deciduous vegetation that would provide habitat for important prey items such as ruffed grouse and hares would be retained by the use of riparian buffers. Canopy openings created by thinning treatments would stimulate deciduous vegetation that would improve habitat quality for grouse. In addition, aspen treatments would occur on 20 acres and would retard the encroachment of conifer species on the aspen stands, which will perpetuate and increase the size of the aspen stands used by grouse. (Revised Preliminary EA at p. 193-195).

3.8 Transportation

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Transportation Resources Report by C. Bauman (2016), available in the project record. Reference information is contained in the full specialist report.

3.8.1 Methodology

The transportation resource indicators analyzed are displayed in **Figure 81**.

Figure 81. Transportation Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Road System	Miles of road in project area by maintenance level	Miles	P&N #7	36 CFR 212.5
	Open (NFS) road density in discrete management areas	Miles per square mile	P&N #7	Okanogan NF LRMP S&G

Resource Indicator: Miles of Road in Project Area by Maintenance Level

Existing roads consist of both NFS roads and Unauthorized roads. A NFS road may be closed (Maintenance Level 1; other road maintenance levels defined in Appendix B) when it is determined it will not be needed for access to meet management objectives for one year or longer. Closing NFS roads reduces the potential environmental impacts and maintenance costs of the road.

A complete inventory of NFS roads in the project area was compiled. In addition, an inventory of existing unauthorized roads was developed. Most roads were field checked and data updated to reflect existing conditions. This information was used to update the project GIS database. As unmapped roads were discovered, they were added to the inventory of unauthorized roads.

Data came from field surveys, GIS data (roads, streams, topography, etc.), and historical data (previous project files, reports, etc.).

Further information about evaluated roads in the Travel Analysis (including timing of road activities by project phase) can be found in Appendix B along with definitions of road maintenance levels and other road related activities such as closure and decommissioning. Recommendations and specialist input made are documented in the Mission Restoration Engineering Resources Report analysis file, as spreadsheets and supplemented with resource specific narratives.

Resource Indicator: Open National Forest System (NFS) Road Density in Discrete Management Areas
Under the Okanogan National Forest Land and Resource Management Plan, roads standards should be consistent with the goals and activities of the management area or the collective requirements of the management areas served.

Using the inventory of NFS roads described above, GIS analysis was conducted overlaying discrete management areas with roads to calculate density. The Mission Restoration project boundary includes, wholly or in part, seven discrete management areas (MA).

3.8.2 Intensity Level Definitions

Type of Impact:

- Beneficial: Changes in transportation system bring the resource indicators closer to management goals.
- Adverse: Changes in transportation system push the resource indicators away from management goals.

Duration of Impact:

- Short-term: Effects to transportation occur only during project and shortly (less than 10 years) post-project.
- Long-term: Effects to transportation occur long than 10 years post-project activities.

Intensity of Impact:

- None: No impact to transportation system or access. May or may not address economic of Analysis requirement 36CFR212.5.
- Negligible: A noticeable change to transportation system via access or economics that would be so small that it would not be of any measurable or perceptible consequence. No change in mileages (<0.1miles total in analysis). May or may not address economic of Analysis requirement 36CFR212.5.
- Minor: A noticeable change to transportation system roads or access opportunities that would be small, localized and of little consequence. Effects on access would be detectable (via open/closed mileage and location). Effects on transportation system would be minor and show only minor change in economics needed for maintenance-affecting only ML2 roads or less and affecting Unauthorized and Non Forest System Roads (FSR) roads.

- Moderate: A distinct measurable change to transportation system that would be measurable through mileage (>1.0 mile) via Forest System Roads (FSR), designation of unauthorized roads, or addressing closures of Non-system or unauthorized roads. These would be readily apparent and measurable, localized and possibly long term. Some measures and effects are long term for visibility or completion; not visible till project completion, or when rehabilitation funds are available- Measurable effects could include mileage available to public use, Maintenance Levels (MLs) decreased, and subsequent maintenance would occur on infrequent basis, providing safety only for the levels planned as required by Transportation Analysis Process 36 CFR212.5.
- Major: A distinct measurable change to transportation system that would be measurable through mileage (>5 miles) via Forest System Roads (FSR), designation of unauthorized roads, or addressing closures of Non-system or unauthorized roads. These would be readily apparent and measurable, localized and possibly long term. Some measures and effects are long term for visibility or completion; not visible till project completion, or when rehabilitation funds are available- Measurable effects could include mileage available to public use, Maintenance Levels (MLs) decreased, more roads closed or decommissioned not accessible for management or public. Subsequent maintenance would occur on infrequent basis, providing safety only for the levels planned as required by Transportation Analysis Process 36 CFR212.5.

3.8.3 Affected Environment

The road system within the analysis area was built over the last 60 years, primarily for access for timber harvest and developed campground. Some roads do not meet current safety or design standards, are located in areas where they adversely impact aquatic habitat and hydrological function or are now in excess to management needs because of changes in logging system practices or management objectives. Additionally, the bridge over West Fork Buttermilk Creek, on road 4300550, is closed due to safety concerns.

The primary access routes into the project area are provided by State Highway 153 and Okanogan County Roads 1049, 1051, 1090, 1091 as well as National Forest System (NFS) roads 4300000, 4340000, 4342100, 4342200, and 4342300.

Figure 82. Transportation Resource Indicators and Measures for Existing Condition

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
Road System	Miles of road in project area by maintenance level	Miles per Maintenance Level (ML)	
		ML 1	62.81
		ML 2	27.63
		ML 3	25.02
		ML 4	3.41
		Miles per square mile	
		(MA5-03)	1.64

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
	Open (NFS) road density in discrete management areas	(MA14-10)	1.25
		(MA17-135)	N/A
		(MA25-13)	0.55
		(MA25-14)	0.53
		(MA25-15)	1.17
		(MA26-06)	0.29
		(MA26-07)	0.19

Resource Indicator: Miles of Road in Project Area by Maintenance Level

Existing roads consist of both NFS roads and Unauthorized roads. A NFS road may be closed (Maintenance Level 1) when it is determined it will not be needed for access to meet management objectives for one year or longer. Closing NFS roads reduces the potential environmental impacts and maintenance costs of the road. Further information about each road evaluated in the Travel Analysis in the Engineering resources analysis file. Timing of road activities by project phase can be found in Appendix B along with definitions of road maintenance levels and other road related activities such as closure and decommissioning.

Figure 83. Current Road System in Project Area

	Open Roads (miles)	Closed Roads (miles)	All Roads (miles)
NFS Roads	56.06	62.81	118.87
Unauthorized Roads*	0	15.78	15.78
Total	56.06	78.59	134.65

*Note that all Unauthorized Roads by definition are not Open roads. Refer to Roads definitions Appendix A: Road Management Activities – Forest Restoration Projects.

Resource Indicator: Open National Forest System (NFS) Road Density in Discrete Management Areas

All management areas within the Mission Forest and Fuels Restoration Project currently meet Forest Plan standard.

Figure 84. Comparison of Current Open Road Density and Forest Plan Standards for Density by Discrete Management Area (MA).

Discrete Management Area (MA)	MA (mi^2)	Forest Plan Standard Density (mi/mi^2)	*Open Road Miles	**Open Road Density (mi/mi^2)
5-03	31.3	***3.0	51.34	1.64
14-10	32.14	2.0	40.20	1.25
17-135	0.06	N/A	0.59	N/A

25-13	6.5	3.0	3.58	0.55
25-14	1.58	3.0	0.84	0.53
25-15	24.2	3.0	28.31	1.17
26--06	3.9	1.0	1.12	0.29
26-07	5.72	1.0	1.1	0.19

*Assumes Unauthorized roads are counted as closed - actual numbers will be somewhat higher depending on how many Unauthorized roads are currently being driven on by highway vehicles. Post-project numbers are correct.
**Calculated using an intersect of the project road layer and discrete management area boundaries and following the Road Density Calculation Guide approved by the Okanogan NF FLT 11-6-1992.
***Forest Plan standard open road density for MA 5 does not include arterials and collectors.

3.8.4 Environmental Consequences

3.8.4.1 Considered, but not Analyzed in Detail

Project activities related to transportation system changes and vegetation management have effects on the engineering resource. The other proposed project activities, such as culvert replacement, prescribed burning, moving the snowmobile gate, building fence, treating invasive plants, etc., will not have an effect on engineering resources and will not be discussed in the effects section.

3.8.4.2 Alternative 1

3.8.4.2.1 Effects

The potential environmental impacts and maintenance costs of the existing roads would continue. The bridge on road 4300550 would stay closed for safety concerns and the environmental impacts of replacement would have to be analyzed as part of a future project.

The direct/ indirect effects of no action on the transportation system would result in continuing high sediment delivery from open roads and no removal or treatment of road stream crossings. This would occur because the current road maintenance funding levels are lower than needed to maintain all the existing roads. All maintenance costs would continue to be the responsibility of the Forest Service. Therefore, these roads would continue to be maintained to a lesser standard; which is not sustainable over the long term. Deferred maintenance costs would continue to increase to this road system with no foreseeable funding to make the necessary repairs. Refer to **Figure 83** and **Figure 84** for current road densities and NFSR mileage by Maintenance Level.

Resource Indicator: Miles of Road in Project Area by Maintenance Level

The effects of Alternative 1 would be negligible, adverse, and long-term because the current funding is less than needed to maintain the existing roads, contributing to adverse for resources needing or affected by roads (less usability/access and sediment contribution) and would occur greater than 10 years.

Resource Indicator: Open National Forest System Road Density in Discrete Management Areas

The effects of Alternative 1 would be negligible, adverse, and long-term because the road density wouldn't change within & outside project area, so minor for transportation density effects, but long term, greater than 10 years because no change would be likely implemented to change the density before that time.

3.8.4.3 Alternative 2

3.8.4.3.1 Effects

Direct/Indirect affects for this alternative is described in the following section.

During project activities, some currently closed NFS roads and unauthorized roads would be opened and maintenance and/or reconstruction activities would occur. Short temporary roads would be constructed for use during vegetation management activities and decommissioned after use. For clear definitions of roads types- NFS, Non-system, unauthorized, or temporary, see to Appendix B. These activities would bring the total miles of open road to 66.15 miles while the remaining 68.49 miles would remain closed or decommissioned. Approximately 55.72 miles of road would be used for log hauling. The bridge over West Fork Buttermilk Creek, on road 4300550, would be replaced in a manner following best management practices. This replacement would occur at a future date when adequate funds become available.

Water source for dust abatement of roads for the Mission Restoration Project will be at areas with large culverts, adjacent hardened sites, with access. All water removal will be in accordance with WDFW/FS MOU. More information on water withdrawal areas can be found in Appendix D.

Figure 85. Transportation Resource Indicators and Measures for Alternative 2

Resource Element	Resource Indicator	Measure	Alternative 2
Road System	Miles of road in project area by maintenance level	Miles per Maintenance Level (ML)	
		ML 1	34.82
		ML 2	37.45
		ML 3	25.29
		ML 4	3.41
	Open (NFS) road density in discrete management areas	Miles per square mile	
		(MA5-03)	1.74
		(MA14-10)	1.17
		(MA17-135)	N/A
		(MA25-13)	1.28
		(MA25-14)	2.41
		(MA25-15)	1.21
		(MA26-06)	0.29

Resource Element	Resource Indicator	Measure	Alternative 2
		(MA26-07)	0.19

Resource Indicator: Miles of Road in Project Area by Maintenance Level

The effects of Alternative 2 on the miles of road in the project area would be moderate, long-term, and beneficial because it would reduce the number of roads to be maintained, allowing limited funds to be used more effectively and reduce impacts, yet facilitate needed access (per TAP requirements) and would be short term, in that it would occur within 10 years. **Figure 86** displays miles of road by maintenance level during the various project phases.

Figure 86. Transportation System Summary* for Alternative 2

	Current Condition	During Harvest Activities	After Harvest Activities	Post-Project
NFS Roads - Open (ML 2-5)[1]	56.06	80.60	63.76	66.15[2]
NFS Roads - Closed (ML 1)[1]	62.81	38.27	50.03	34.82
NFS Roads – Decommissioned[1]	0	0	5.07	33.6

**Figures are in miles; totals are to be considered approximate due to mapping errors and rounding.*
[1] Figures for during and after harvest activities and post-project reflect the addition of 7.09 miles of unauthorized
[2] Figure includes ML2 Admin which has very limited motorized use access.

Resource Indicator: Open National Forest System Road Density in Discrete Management Areas

Open road density by discrete MA during the project and post-project is shown in **Figure 87**. For during harvest and after harvest activities, open road densities will not exceed or increase above Forest Plan Standard. MA 25 numbers indicate an increase of open roads post project compared to initial existing condition. These numbers are the result of finding more roads present on landscape during planning, adding some into corporate data base as the open road FSR system. It doesn't reflect the roads found and Decommissioned from the existing condition in the MAs. The effects of Alternative 2 on the road density in the project area would be moderate, short-term, and beneficial because road densities will not change outside the project area but will lessen due to reductions within the analysis area; therefore minor on density effects, but beneficial in both short and long-term as densities are within the Okanogan National Forest Land and Resource Management Plan and moves toward compliance with 36CFR212.5.

Figure 87. Open Road Density by Project Phase and Discrete Management Area for Alternative 2

Discrete Management Area (MA)	MA Area (mi.²)	Forest Plan Standard Density (mi./mi²)	During Harvest		After Harvest		Post-Project	
			Open Road Miles	Open Road Density (mi./mi²)	Open Road Miles	Open Road Density (mi./mi²)	Open Road Miles	Open Road Density (mi./mi²)
5-03	31.30	3.0	59.97	1.9	54.64	1.75	54.33	1.74

14-10	32.14	2.0	45.52	1.42	38.72	1.20	37.72	1.17
17-135	0.06	N/A	0.59	n/a	0.84	n/a	0.59	N/A
25-13	6.50	3.0	5.18	0.80	5.09	0.78	9.85	1.28
25-14	1.58	3.0	4.07	2.58	4.06	2.57	8.34	2.41
25-15	24.20	3.0	34.08	1.41	30.02	1.24	29.31	1.21
26-06	3.90	1.0	1.12	0.29	1.12	0.29	1.12	0.29
26-07	5.72	1.0	0.24	0.04	0.86	0.15	1.10	0.19

3.8.4.4 Alternative 3

3.8.4.4.1 Effects

The direct/ indirect effects of this alternatives are described in the following section.

During project activities, some currently closed NFS roads and unauthorized roads would be opened and maintenance and/or reconstruction activities would occur. These activities would bring the total miles of open and administrative use roads to 44.6 miles while the remaining 90.1 miles would remain closed or decommissioned. Approximately 55.72 miles of road would be used for log hauling. The roads and their miles for both Alternative 2 & 3 are the same for log haul. Therefore, both the direct and indirect effects of Alternative 3 would be the same as discussed in Alternative 2 regarding timber harvest activities. The effects between the two alternatives differ post project; with more NFSR roads being closed or decommissioned. . Additionally, Alternative 3 would allow for a temporary crossing to be constructed across West Fork Buttermilk Creek on the 4300550 road to allow equipment access to roads slated for decommissioning. After decommissioning has occurred, the temporary crossing would be removed and the existing bridge would stay in place.

Figure 88. Transportation Resource Indicators and Measures for Alternative 3

Resource Element	Resource Indicator	Measure	Alternative 3
Road System	Miles of road in project area by maintenance level	Miles per Maintenance Level (ML)	
		ML 1	33.80
		ML 2	16.02
		ML 3	25.29
		ML 4	3.41
	Open (NFS) road density in discrete management areas	Miles per square mile	
		(MA5-03)	1.70
		(MA14-10)	0.91
		(MA17-135)	N/A
		(MA25-13)	0.31
		(MA25-14)	1.45
		(MA25-15)	1.09

		(MA26-06)	0.29
		(MA26-07)	1.70

Resource Indicator: Miles of Road in Project Area by Maintenance Level

The effects of Alternative 3 on the miles of road in the project area would be moderate, long-term, and beneficial because it would reduce the number of roads to be maintained, allowing limited funds to be used more effectively and reduce impacts, yet facilitate needed access (per TAP requirements) and would be short term, in that it would occur within 10 years. Its effect for effective on road maintenance is similar to Alternative 2, because it is close to the same mileage open for the ML3-4s, but has less open roads. Like Alternative 2 it contains the rocked crossings which require maintenance. So those costs would remain. **Figure 89** displays miles of road by maintenance level during the various project phases.

Figure 89. Transportation System Summary* for Alternative 3

	Current Condition	During Harvest Activities	After Harvest Activities	Post-Project
NFS Roads - Open (ML 2-5)[1]	56.06	80.60	63.76	44.6[2]
NFS Roads - Closed (ML 1)[1]	62.81	38.27	50.03	33.9
NFS Roads – Decommissioned[1]	0	0	5.07	56.2

**Figures are in miles; totals are to be considered approximate due to mapping errors and rounding.*
[1] Figures for during and after harvest activities and post-project reflect the addition of 7.09 miles of unauthorized roads to the NFS.
[2] Figure includes ML2 Admin which has very limited motorized use access.
Note Unauthorized at project end is eliminated by decision to Decommission, or adopt as NFSR.

Resource Indicator: Open National Forest System Road Density in Discrete Management Areas

Open road densities post-project decrease in the project area. Open road density is shown for each phase of the project in the figure below.

Open road density by discrete MA during the project and post-project is shown for Alternative 3 below, in **Figure 90**. For during and after harvest activities, plus Post-Project the road density for all the MAs will meet Forest Plan Standard; being below the thresholds. It doesn't reflect the roads found then Decommissioned from the existing condition in the MAs. The effects of Alternative 3 on the road density in the project area would be moderate, short-term, and beneficial because road densities will not change outside the project area but will lessen due to reductions within the analysis area; therefore minor on density effects, but beneficial in both short and long-term as it moves toward compliance with 36CFR212.5

Figure 90. Open Road Density by Project Phase and Discrete Management Area for Alternative 3

Discrete Management Area (MA)	MA Area (mi.²)	Forest Plan Standard Density (mi./mi²)	During Harvest		After Harvest		Post-Project	
			Open Road Miles	Open Road Density (mi./mi²)	Open Road Miles	Open Road Density (mi./mi²)	Open Road Miles	Open Road Density (mi./mi²)
5-03	31.30	3.0	59.26	1.89	53.37	2.16	53.06	1.70
14-10	32.14	2.0	45.39	1.41	33.20	1.03	29.29	0.91
17-135	0.06	N/A	0.59	n/a	14.89	N/A	0.59	N/A
25-13	6.50	3.0	3.90	0.60	3.82	0.59	0.23	0.04
25-14	1.58	3.0	2.50	1.58	2.30	1.46	0.77	1.45
25-15	24.20	3.0	33.59	1.39	28.83	1.19	0.44	1.09
26-06	3.90	1.0	1.12	0.29	1.12	0.29	0.29	0.29
26-07	5.72	1.0	1.10	0.19	1.10	0.19	1.10	0.19

3.8.4.4.2 Cumulative Effects

There are no other projects currently planned or in future foreseeable activities that would affect the resource indicators of open roads or road densities.

Other actions proposals in the alternatives have the following general direct/indirect effects, but are not good resources indicators and measures. The following narrative compares those action effects.

Proposed rocking, and reinforcement of riparian/ stream areas will necessitate more roads maintenance than the current condition (Alternative 1). Alternatives 2 & 3 are almost identical in the Rock Armoring proposal, except for two (2) road segments, where Alternative 3 would decommission the roads of 4300550. Rock armoring would not occur at those two locations, since the road would be decommissioned in Alternative 3. Maintenance on about 1/3 of the crossings are on ML 2 roads, and not likely to occur unless scheduled with non- appropriated funds. The other crossings (approximately 2/3) are on ML 3 roads, and are likely to receive maintenance more frequently.

Culvert replacement proposed for Both Alternatives 2 and 3 are likely to have only the effects of timing and funding for travel access on those routes. During replacement, there would be interruptions in access for both administrative and public use.

3.8.4.5 Summary of Effects

There are fewer roads and lower road densities in Alternative 3 compared to Alternative 2. Like Alternative 2, there are fewer NFSR road than the Existing Condition described for Alternative 1. Road densities for Existing Condition vs Post Project for Alternative 1 are higher than Alternative 2, and subsequently Alternative 2 is higher than Alternative 3. Both Action Alternatives meet Forest Plan (FLMP) Standards and Guidelines.

Figure 91. Transportation Resource Indicators and Measures for Cumulative Effects

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)	Alternative 2	Alternative 3
Road System	Miles of road in project area by maintenance level	Miles per Maintenance Level (ML)			
		ML 1	62.81	34.82	33.80
		ML 2	27.63	37.45	16.02
		ML 3	25.02	25.29	25.29
		ML 4	3.41	3.41	3.41
	Open (NFS) road density in discrete management areas	Miles per square mile			
		(MA5-03)	1.64	1.74	1.70
		(MA14-10)	1.25	1.17	0.91
		(MA17-135)	N/A	N/A	N/A
		(MA25-13)	0.55	1.28	0.31
		(MA25-14)	0.53	2.41	1.45
		(MA25-15)	1.17	1.21	1.09
		(MA26-06)	0.29	0.29	0.29
		(MA26-07)	0.19	0.19	1.70

3.8.5 Consistency Statement

Both proposed action alternatives meet applicable regulations and laws (LRMP and CFR).

3.9 Botany

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Botany Resources Report by K. Baraibar (2016), available in the project record. Reference information is contained in the full specialist report.

3.9.1 Methodology

The resource elements, indicators, and measures used to analyze and compare potential effects of the Mission Restoration on botanical resources are shown in Figure 92. Indicators and measures address the purpose and need and key internal issues raised during project planning.

Figure 92. Botanical Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
R6 Sensitive plant *Botrychium crenulatum*	Viability of occupied *B. crenulatum* habitat	Poor, Fair, or Good	P&N # 5	S/G 6/19, FSM 2620, FSM 2670
	Population and individual plant count and vigor	Numbers of populations or individual plants	P&N # 5	S/G 6/19, FSM 2620, FSM 2670
Unique and Sensitive Plant Habitats	Change in aspen stand vigor and plant biodiversity	Acres of unique and sensitive habitat treated	P&N # 5	FSM 2670.2 and FSM 2670.3
Understory Vegetation Composition	Change in amount and diversity of understory vegetation	Acres of forest canopy opened	P&N # 3	FSM 2670

Prior to conducting botanical surveys for Sensitive and Survey and Mange (S&M) plant species, all existing data regarding known populations and habitats in the project area was analyzed. Data was collected from Methow Valley Ranger District (MVRD or District) past botanical survey records, Natural Resource Information System (NRIS), and the Washington Natural Heritage Program (WNHP) rare plant database. Habitat data was compiled from prior survey data as well as Okanogan-Wenatchee National Forest GIS layers. Species on the 2015 Region 6 Regional Forester's Interagency Special Status Species list and the 2003 Survey and Manage species list were surveyed for this analysis (See appendices in the Botany Resources project folder). The surveys were conducted at the time of year when plants are identifiable. The Intuitive Controlled method was used to conduct surveys. This method is defined as follows: the surveyor has given the area a closer look by conducting a complete survey through a specific area of the project after walking through the project area and perimeter or by walking more than once through the area. Most of the project area is examined (USDA 2005b).

Spatial and numerical data collected are stored in the Region 6 Natural Resource Information System database. Effects are analyzed by determining where disturbance will overlap with R6 Sensitive and S&M populations, determining the nature and level of disturbance, and assessing plant's vulnerability to the disturbance.

All known R6 Sensitive and S&M populations documented in the project area were delineated and mapped. When populations were small enough, exact counts of individuals were taken. For larger populations, the number of individuals was estimated based on smaller subsets of data. Acreage of each population was determined using GIS software.

This project uses information from photo interpretation, field reconnaissance, and analysis results of the Ecosystem Management Decision Support (EMDS) tool to identify restoration and

wildfire hazard reduction needs at the stand and landscape levels in the project area. A majority of the Unique and Sensitive Habitats were areas identified by the North Central Washington Forest Health Collaborative (NCWFHC) that focused on aspen restoration. The Forest Service used the GIS deciduous vegetation models and National Agriculture Imagery Program (NAIP) aerial imagery to identify additional Unique and Sensitive Habitats.

The same models and methods above were used to identify forested habitats for restoration treatments where understory vegetation composition would be enhanced and maintained by treating overstory vegetation.

Resource Indicator: Viability of occupied B. crenulatum habitat and population and individual plant count and vigor

Identification of threats is somewhat challenging for moonworts (which includes *B. crenulatum*), since so much information is still needed on habitat requirements, environmental tolerances and the effects of management. In a conservation assessment written by Ahlenslager and Potash (2007), threats to moonworts in Oregon and Washington (ORNHIC 2002; WNHP 2002) are actions that alter existing site characteristics, including actions that would change the microclimate, canopy coverage, hydrology, or mycorrhizal association on a site from the regime that has supported a given population over the past decade. The moderate threat from logging and other vehicular activities is the actual physical disturbance of the soil that breaks root and mycorrhizae connections or otherwise uproots the moonwort plants (Ahlenslager and Potash 2007). Some *B. crenulatum* populations would be excluded from both thinning and prescribed fires treatments, while others would be included in order to improve population vigor. In sites where treatments would be avoided, established boundaries around plant locations have been delineated, and a 50-foot buffer would be applied. All *B. crenulatum* populations involved in project treatments would be monitored over the course of the project and the results of this monitoring may result in modifications of design criteria.

Indicator: In this analysis, viability of occupied *B. crenulatum* is measured as good, fair or poor. A rating of good means actions over the last decade have not altered the habitat requirements listed above for occupied *B. crenulatum*. A fair rating means there have been some habitat alterations over the last decade. Under a fair rating, populations have remained stable but may experience a downward trend as habitat viability is at risk due to actions that has changed the microclimate. A rating of poor would mean the viability of the occupied habitat has been on a downward trend, and *B. crenulatum* within that habitat have been decreasing in numbers over the past decade. Population count and vigor of *B. crenulatum* near treatment areas will be documented, where accidental or unforeseen treatment effects to Sensitive plant populations has occurred. Population count and vigor of *B. crenulatum* that have been included in treatment areas.

Analysis Methods: Funding implementation, including monitoring will be scheduled and requested on a yearly basis. Monitoring would occur at all *B. crenulatum* populations within unit boundaries.

Analysis Area: *B. crenulatum* sites within the project area and their immediate surrounding habitats would be analyzed.

Resource Indicator: Change in aspen stand vigor and plant biodiversity
In dry east-side forests, aspen and wetland ecosystems are limited across the landscape and are biodiversity hotspots for wildlife and plant species. These unique habitats usually have deeper, richer soils than the surrounding coniferous forests. The partial shading overstory and rich soil in the understory supports many herbs, forbs, and grasses in the understory community (Seager et al. 2013). Aspen's palatable twigs and foliage, and tendency to develop cavities, make it valuable habitat for wildlife such as deer (*Odocoileus* sp.), elk (*Cervus elephas*), woodpeckers, and songbirds (Swanson et al. 2010). Mature competing conifers can suppress aspen overstory trees, and conifers of any size can suppress growth of aspen suckers. In addition, conifers compete strongly for soil moisture with aspen in an environment where moisture is often in short supply (Swanson et al. 2010). Succession of aspen to conifers in our area is driven by both the greater shade tolerance of the conifers, and by competition for moisture (Swanson et al. 2010). Conifers intercept more moisture than aspen, especially snow (DeByle 1985).

Indicator: Aspen stand and wetland vegetation vigor. Increase of vegetation and biodiversity of plant species.

Analysis Methods: Funding implementation, including monitoring will be scheduled and requested on a yearly basis. Monitoring would occur in select aspen stands and wetlands within the project area.

Analysis Area: Sensitive and Unique habitats within the project area were analyzed

Resource Indicator: Change in amount and diversity of understory vegetation
Analysis relies on a comparison of the amount of cover and diversity of native species before and after treatment.

Indicator: Increase/Decrease in Amount/Diversity of Cover

Analysis Methods: Funding implementation, including monitoring will be scheduled and requested on a yearly basis.

Analysis Area: Select forested areas proposed for restoration treatments.

3.9.2 Intensity Level Definitions

Type of Impact:

- Beneficial: An increase in *B.crenulatum* populations/ species count and vigor near treatment areas. An increase in aspen stand vigor and plant diversity in unique habitats. An increase in the amount and diversity of understory vegetation.
- Adverse: A decrease in *B.crenulatum* populations/species count and vigor near treatment areas. A decrease in aspen stand vigor and plant diversity in unique habitats. A decrease in the amount and diversity of understory vegetation.

Duration of Impact:

- Short term: Immediately through the first growing season after treatments.
- Long term: 1 to 20 years post-treatment.

Intensity of Impact:

- Negligible: A change to botany resources that would be so small that it would not be of any measurable or perceptible consequence. Sensitive plants, unique habitats and understory vegetation would not be affected or the effects to these plants would not be detectable.
- Minor: Change to sensitive plants, unique habitats and understory vegetation would be detectable, although these effects would be localized and of little consequence. Minor effects to understory vegetation would be less half an acre in any given location. Activities would not physically disturb individual sensitive plants. Unique habitats may experience alterations, however, overall ecological functioning would be inconsequential and immeasurable.
- Moderate: A change to botany resources that would be readily apparent and measurable. Measurable effects could include physical disturbance or removal of sensitive plants, and disturbance to unique habitats and understory vegetation. Disturbance to understory vegetation would be more than half an acre in any given location.
- Major: Effects to sensitive plants, unique habitats and understory vegetation would be readily apparent, measurable, severe, and would occur on a regional scale. The viability of plant populations, unique habitats and understory vegetation would be altered. Mitigation measures to offset effects would be extensive and success would not be assured.

3.9.3 Affected Environment

Botrychium crenulatum (scalloped moonwort) is considered a Sensitive species according to the Region 6 ISSSSP 2015 list. *B. crenulatum* occurs within, or in close proximity to unit boundaries.

Habitats for B. crenulatum will be discussed and analyzed, as populations of this species are either within unit boundaries or in close proximity.

Figure 93. Botanical Resource Indicators and Measures for the Existing Condition

Resource Element	Resource Indicator (Quantify if possible)	Measure (Quantify if possible)	Existing Condition (Alternative 1)
R6 Sensitive plant *Botrychium crenulatum*	Viability of occupied *B. crenulatum* habitat	Poor, Fair, or Good	Fair
	Population and individual plant counts of *B. crenulatum*	Numbers of populations or individual plants	5 populations totaling 40 individuals

Unique and Sensitive Plant Habitats	Change in aspen stand vigor and plant biodiversity	Acres of unique and sensitive habitats treated	0 acres
Understory Vegetation Composition	Change in amount and diversity of understory vegetation	Acres of forest canopy opened	0 acres of forest canopy opened. Sparse or no understory in areas with closed canopy.

Resource Indicator: Viability of occupied B. crenulatum habitat
Two proposed treatment units (16 and 503) have known populations of *B. crenulatum*. There are patches of dense conifer canopies surrounding the occupied habitat in these units. Encroaching conifers could displace riparian trees and shrubs that are associated with *B. crenulatum* habitats. Dense stands of conifers could also lead to a high severity fire which could mean a long recovery time for vegetation. Conifer encroachment and the potential for fire processes occurring outside their biophysical baseline conditions in the occupied sites, makes the current surrounding habitat fair quality.

Resource Indicator: Population and individual plant counts of B. crenulatum
Five populations of the R6 Sensitive plant, *B. crenulatum* occurs within the analysis area in moist- wet riparian areas with saturated soils, dominated by riparian vegetation such as *Populus tremuloides* (aspen) and *Cornus sericea* subsp. *sericea* (red osier dogwood). *B. crenulatum* requires nearly permanent moisture, often occurring in saturated headwater fens and seeps (Farrar 2006). It is usually found in partly shaded to heavily shaded sites at mid to high elevations (Farrar 2005). There is an accumulation of downed debris and a dense overstory and understory of both riparian and upland vegetation. Conifer encroachment and fire behavior outside the range of scientifically acceptable ecological consequences, could be a threat to these sites.

Two populations, totaling 9 individuals occurs in riparian habitats within proposed treatment units, and three populations totaling 31 individuals occurs in riparian habitats outside unit boundaries.

Resource Indicator: Change in aspen stand vigor and plant biodiversity
Unique and Sensitive Plant Habitats are dominated by aspen and other deciduous riparian vegetation. Aspen stands within some units have a multi-age structure where mature aspen dominate the overstory and younger aspen are establishing where the overstory canopy has opened. Other stands have a single age structure, where mature aspen dominate the overstory but young aspen regeneration is limited by both conifers and mature aspen. Conifer encroachment in the overstory and understory within these habitats are limiting available sunlight, nutrients and water on which the riparian vegetation depend.

Conifer encroachment and closed canopies are limiting available nutrients, water and sunlight to the riparian vegetation in unique and sensitive plant habitats.

Resource Indicator: Change in amount and diversity of understory vegetation
Current conditions in the forested area in the two sub-watersheds are dominated by dense, multi-layered forest. In the Libby Creek sub-watershed, there is an excess of small patches of dense, young trees. The Buttermilk sub-watershed has excessive areas and large patch sizes of dense, multi-story forests. Current overstory vegetation conditions are decreasing the amount and diversity of understory vegetation composition.

The understory vegetation composition in the analysis area is decreasing in amount and diversity due to lack of available resources caused by closed canopies and dense patches of young trees.

3.9.4 Environmental Consequences

3.9.4.1 Considered, but not Analyzed in Detail

Botanical resources would not be affected by proposed transportation changes (closing, opening, or decommissioning roads), culvert replacement, coarse woody debris enhancement, or soil treatments as these activities would not occur in locations that have known populations of R6 Sensitive plants species. The activities mentioned above would have negligible effects on unique and sensitive habitats and understory vegetation.

Additionally, **Figure 94** displays plant species considered but not analyzed in detail.

Figure 94. Botanical Resources Considered But Not Analyzed in Detail

Resource	Rationale for Dismissing from Further Analysis
Endangered Plant Species	Two Endangered plant species are known to occur on the Okanogan-Wenatchee National Forest; showy stickweed (*Hackelia* venusta) and Wenatchee Mt. checker-mallow (*Sidalcea oregana var. calva*). There are no known populations of these species on the Okanogan portion of the Forest. These species were not located during field inventory and there is no suitable habitat for them within the project area.
Threatened Plant Species	Two Threatened plant species are known to occur on the Okanogan-Wenatchee National Forest; water howellia (*Howellia aquatalis*) and Ute ladies'-tresses (*Spiranthes diluvialis*). There are no known populations of these species on the Okanogan portion of the Forest. These species were not located during field inventory and there is no suitable habitat for them within the project area.
Sensitive and Survey and Manage (S&M) Plant Species	There is one R6 Sensitive species, *Pinus albicaulis* (whitepark pine) and two S&M species, *Mycena overholtsii* (Cat B fungi) and *Botrychium montanum* (Mountain moonwort- Cat A vascular plant), which occur within the project boundary. Populations of *P. albicaulis, Mycena overholtsii* and *Botrychium montanum* occurring within the analysis area, but in isolated locations where there would be no effects from the proposed treatments, will not be analyzed.

3.9.4.2 Alternative 1

3.9.4.2.1 Effects

Under a no-action alternative, existing populations of *B. crenulatum* would remain stable in the short-term, but plant vigor within these populations would decrease due to competition for light, water and nutrients from dense over/understory vegetation. A no-action alternative would have long term, moderate adverse impact from canopy closure on *Botrychium crenulatum* populations, unique and sensitive habitats and understory native plant species. In addition, there would be long term moderate adverse impact on *B. crenulatum* and unique and sensitive habitats from potential stand replacement fire. Unique and Sensitive habitat conditions would deteriorate over time due to the encroachment of conifers from lack of thinning and prescribed fire treatments. There would be a trend of overstory and understory tree build-up due to the lack of thinning and prescribed fire, which could contribute to large wildfires in the future and would decrease the amount and diversity of understory vegetation composition.

3.9.4.3 Alternatives 2 and 3

The effects for R6 Sensitive plants in Alternative 2 would be the same as those described for Alternative 3 and therefore are considered the same for analysis.

3.9.4.3.1 Effects

Botanical resources would not be affected by proposed transportation changes (closing, opening, or decommissioning roads), culvert replacement, coarse woody debris enhancement or soil treatments as these activities would not occur in locations that have known populations of R6 Sensitive plants species. The activities mentioned above would have negligible effects on unique and sensitive habitats and understory vegetation.

Figure 95. Botany Resource Indicators and Measures for Alternatives 2 and 3

Resource Element	Resource Indicator (Quantify if possible)	Measure (Quantify if possible)	Alternative 2 & 3
R6 Sensitive plant *Botrychium crenulatum*	Viability of occupied *B. crenulatum* habitat	Poor, Fair, or Good	Good
	Population and individual plant counts of *B. crenulatum*	Numbers of populations or individual plants	5 populations totaling 40 individuals (2 populations in treatment units; 3 populations outside of treatment units)
Unique and Sensitive Plant Habitats	Change in aspen stand vigor and plant biodiversity	Acres of unique and sensitive habitats treated	280 acres

Understory Vegetation Composition	Change in amount and diversity of understory vegetation	Acres of forest canopy opened	10,255 acres of forest canopy opened.

Resource Indicator: Viability of occupied B. crenulatum habitat
B. crenulatum is found within two unit boundaries (units 16 and 503). Proposed treatments in these units include commercially harvesting or girdling conifers for aspen release, ladder fuel thinning in the understory, and underburning. The population in unit 16 is in an area flat enough for tractor logging, so there would be no effect from skyline cable logging. No roads are proposed over the population. There is occupied *B. crenulatum* habitat within proposed beaver habitat enhancement treatments. Design criteria have been established to protect the viability of the habitat.

This species needs some overstory, but excess shade causes an adverse, long-term, moderate impact by reducing the amount of light needed for this species to maintain itself. Conversely, too much opening of the canopy around the population may make the site too hot and dry for the species. Thinning the canopy and using prescribed fire would have a long-term, moderate benefit keeping the canopy open enough for *B. crenulatum* to maintain itself, thus meeting Purpose and Need #5 to maintain and enhance existing and potential R6 Sensitive, Survey and Manage plant populations and Unique habitats within meadows and aspen stands. The above treatments would have a long-term, moderate benefit to *B. crenulatum* habitats by mimicking natural effects of wildfire and reducing the likelihood of damage from wildfires that are occurring outside of their biophysical baseline conditions.

Design features and mitigation measures identified as part of Alternative 2 and 3 call for identification and avoidance of *B. crenulatum* when locating slash piles or skid trails. Design criteria also call for underburning while soils within the occupied *B. crenulatum* sites are moist in order to protect the population from intense fire that may damage this species. The equipment buffer zone for Riparian Reserves would be adequate to protect *B. crenulatum* populations occurring in close proximity to proposed unit boundaries.

Resource Indicator: Population and individual plant counts of B. crenulatum
Given the design features and mitigation measures, negligible to minor, short term, adverse impacts would occur to the species from harvesting, thinning, prescribed fire treatments, beaver habitat enhancements, and aquatic enhancement projects. There could be a beneficial, moderate long term impact to *B. crentulatum;* individual plant counts within these populations may increase due to decreased competition from conifers and the increased availability of nutrients, water and sunlight, meeting Purpose and Need #5. There would be a long term moderate beneficial impact to *B. crenulatum* populations and individual plants from the reduced likelihood of stand replacement fire from thinning and prescribed fire treatments.

Resource Indicator: Change in aspen stand vigor and plant biodiversity
A total of 20 Sensitive and Unique habitats units are proposed for restoration treatments where encroaching conifers would be commercially thinned and/or girdled, with prescribed fire. As a

result, treatments within aspen stands would have a moderate, beneficial, long term affect by increasing plant biodiversity as well as stand vigor, and meeting Purpose and Need #5. Ecosystem functioning would improve by increasing the availability of water, sunlight and nutrients. Aspen are shade intolerant and susceptible to conifer competition and replacement in the absence of disturbance such as fire, timber harvest, or pest/disease outbreak. Conifers will eventually overtop the aspen, reducing the aspen overstory and contributing to stand collapse (Seager et al. 2013). Openings created by conifer removal would encourage suckering of young aspen, creating a moderate, long-term benefit. A diverse age structure in aspen stands is beneficial, as it can provide protection against the effects of wildfire, insects and disease and browsing. There would be a long term, moderate beneficial impact to unique and sensitive habitats from the reduced likelihood of stand replacement fire from commercial thinning, girdling, and prescribed fire treatments.

Resource Indicator: Change in amount and diversity of understory vegetation
Approximately 10,255 acres of closed forest canopies and dense patches of young trees are proposed for thinning and prescribed fire treatments. The use of slash mats by heavy equipment used for commercial thinning during summer months would cause adverse, short term, moderate damage to understory vegetation. In skyline units where cables are used, there would be an adverse, short term, moderate impact to understory. Prescribed fire would also reduce vegetation cover in the short term. Prescribed fire and thinning treatments would have a long term, moderate benefit to understory vegetation by increasing plant vigor and diversity. Thinning and prescribed fire treatments would open up the tree canopy in the analysis area, allowing more light to get to the ground and less competition for soil resources such as water. More understory vegetation would grow, with more diversity of forb and graminoid species. This treatments would meet Purpose and Need #3 by maintaining and restoring forest vegetation characteristics to within estimated historical and future ranges of variability to improve forest resiliency to insect, disease, and wildfire events. Early successional species favored by disturbance would be maintained or increase in the analysis area (Weaver 1951; McConnell and Smith 1970; Dodson et al. 2008; Harrod et al. 2008; Stark et al. 2006; Sullivan et al. 2009; Dodson and Peterson 2010; Ferguson et al. 2011).

Snowberry (*Symphoricarpos albus*) occurs in portions of the analysis area. It is utilized by wildlife such as deer and grouse. Disturbance by heavy equipment operating during summer logging or prescribed fire line construction would damage snowberry tops but its underground rhizomes would allow it to persist. With more open canopy, the species could increase with time (Noste and Bushey 1987; Morgan and Neuenschwander 1988; Stark et al. 2006; Nelson et al. 2008).

Small amounts of willow (*Salix scouleriana*) a shrub that wildlife browse, occur in upland areas. If the top of a willow plant is damaged by logging or prescribed fire it could resprout from the roots and maintain itself (Leege 1979; Noste and Bushey 1987; Harrod et al. 2008).

Strawberries (*Fragaria vesca* and *F. virginiana*) are forbs that produce berries consumed by wildlife. Strawberries can suffer damage to tops from hot fire (McLean 1969) or logging. With

time, Fragaria tends to increase after disturbance (Armour et al. 1984; Nelson et al. 2008; Stark et al. 2006; Sullivan et al. 2008).

The shrub kinnikinnick (*Arctostaphylos uva-ursi*) produces a fruit used as food by wildlife species. Kinnikinnick is susceptible to tops of the plants burning, but with time tends to increase after prescribed fire (Harrod et al. 2008; Nelson et al. 2008; Sullivan et al. 2008).

An increase of flowering forbs and shrubs would better support pollinators, e.g. butterflies and bumblebees (Miller and Hammond 2007; Pengelly and Cartar 2010; Neill and Puettmann 2013). This increase would be a result of proposed treatments. More pollinators would promote seed production and help maintain understory species.

3.9.4.3.2 Cumulative Effects

Spatial and Temporal Context for Effects Analysis

The spatial boundaries for analyzing the cumulative effects to botanical resources are within the boundaries defined by the analysis area. Analyzing cumulative effects outside the analysis areas would have no relevancy to botanical resources, as cumulative effects would be too far removed to be impactful.

The temporal boundaries 20 years into the future, the period of post-treatment understory vegetation response.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

Past Actions: In order to understand the contribution of past actions to the cumulative effects of the proposed action, this analysis relies on current environmental conditions as a proxy for the impacts of past action. This is because existing conditions reflect the aggregate impact of all prior human actions on natural events that have affected the environment and might contribute to cumulative effects.

Present and Future Actions: Of the list of past, present and reasonably foreseeable future activities, those that are pertinent to the analysis of cumulative effects to botanical resources include ongoing cattle grazing, recreation uses (including legal and illegal OHV use, snowmobiling, dispersed and developed camping, and sightseeing), firewood cutting, fire suppression, and ongoing weed control.

Resource Indicator: Impact on occupied B. crenulatum habitat

Cattle currently have access to *B. crenulatum* habitat and minimal amount of cattle use is evident. Firewood cutting and other recreational uses have no or immeasurable effects on habitat.

Resource Indicator: Population and individual plant counts of B. crenulatum

Cattle currently have access to *B. crenulatum* populations and individual plants and minimal amount of cattle use is evident. Firewood cutting and other recreational uses have no or immeasurable effects on populations and individual plant counts.

Resource Indicator: Change in aspen stand vigor and plant biodiversity
Currently aspen canopy allows access to cattle but there is very minimal sign of use in these stands. It is unlikely that cattle will impact aspen stands enough to change the stand vigor or plant biodiversity. Weed control may change biodiversity but would focus on removal of harmful weeds. Weed control activities are also monitored for change and environmental effects. Firewood cutting and other recreational uses have no or immeasurable effects on aspen stand vigor and plant biodiversity.

Resource Indicator: Change in understory composition
Cattle grazing, weed control, firewood cutting, and other recreational activities may affect the understory composition, especially within grazing allotment boundaries, but the effect will be minor and will not change the status of the resource indicator.

Summary of Cumulative Effects
Under Alternatives 2 and 3, there would be negligible cumulative effects to the viability of B. crenulatum habitat or populations. The action alternatives would have a long term beneficial moderate effect by creating more transitory range, potentially changing cattle distribution in the analysis area and their access to sensitive plant populations. The B. crenulatum population occurs in an area where several hundred acres would be treated with thinning, ladder fuel reduction thinning, underburning or pile burning. The action alternatives would have a long-term, beneficial, minor effect on B. crenulatum populations because thinning and prescribed fire treatments would help create more transitory range that would disperse cattle over more ground, thereby reducing the potential for cumulative impacts from grazing and trampling. Recreational activities, firewood cutting and special forest products collections would have a long term, minor, adverse effect minimal effect on resource indicators, as they these activities involve vehicle and foot travel which can be vectors for invasive plant spread establishment. Weed control would be beneficial in and near aspen stands and in forest understories by decreasing the amount of spread and establishment of weedy species and increasing the availability of valuable resources.

3.9.4.4 Summary of Effects
A No Action Alternative would have a long term, moderate, adverse effect on understory vegetation by decreasing plant vigor and diversity. Dense pockets of conifers would continue to grow, leading to closed canopy with less light getting to the ground. With less light, many understory species would have a hard time growing and surviving. There would be less diversity of species and cover in understory shrub, forb, and graminoid plants. This Alternative would have a Long term, moderate adverse impact from canopy closure on *B. crenulatum* populations, unique and sensitive habitats and understory native plant species. It would also have a long term moderate adverse impact on *B. crenulatum* and unique and sensitive habitats from potential stand replacement fire.

Alternative 2 and 3 would have a long term moderate beneficial impact to *B. crenulatum* populations, unique and sensitive habitats and native understory species by decreasing shade and competition for nutrients and sunlight. These two alternatives would have a long term moderate beneficial impact *B. crenulatum*, unique and sensitive habitats and native species

from reduced likelihood of stand replacement fire. With mitigation to protect sensitive plants, Alternatives 2 and 3 would allow sensitive species to sustain themselves and maintain viability in the analysis area. Activities such as thinning, ladder fuel reduction thinning, and prescribed burning would have a long term, moderate benefit to understory vegetation by opening up the canopy, favoring the growth of understory plant species. There would be more diversity and cover of understory plants.

Figure 96. Summary of Alternative for Botany Resource Indicators

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)	Alternative 2 & 3
R6 Sensitive plant *Botrychium crenulatum*	Viability of occupied *B. crenulatum* habitat	Poor, Fair, or Good	Fair	Good
	Population and individual plant counts of *B. crenulatum*	Numbers of populations or individual plants	5 populations totaling 40 individuals	5 populations totaling 40 individuals (2 populations in treatment units; 3 populations outside of treatment units)
Unique and Sensitive Plant Habitats	Change in aspen stand vigor and plant biodiversity	Acres of unique and sensitive habitats treated	0 acres	280 acres
Understory Vegetation Composition	Change in amount and diversity of understory vegetation	Acres of forest canopy opened	0 acres of forest canopy opened. Sparse or no understory in areas with closed canopy.	10,255 acres of forest canopy opened.

3.9.5 Consistency Statement

Okanogan National Forest Land and Management Plan

S&G 6-19 addresses Sensitive species, stating, “Sensitive plants and animals should be protected.” Through design criteria and mitigation measures, this project will be in compliance with FP S&G 6-19.

Forest Plan Amendment Effects on Substantive Provisions

To meet Purpose and Needs #2, #3, #4 and #6 identified in Chapter 1 of the EA, vegetation management through thinning would reduce deer winter range cover below Okanogan National Forest Land Resource Management Plan Standard and Guidelines MA14-6A and MA26-6A, requiring a project-specific amendment. The 2012 Planning Rule as amended (36 CFR 219) requires consideration of how such an amendment would affect substantive provisions identified

in the Planning Rule. With respect to botanical resources, the following substantive provisions would be affected by the proposed amendment:

219.9(a)(2)(ii) Key Characteristics. With regard to ecosystem diversity, thinning on up to 746 acres of deer winter range under this amendment in alternatives 2 and 3 would have a long term, moderate, beneficial effect on key characteristics associated with terrestrial ecosystem types in the project area by increasing community heterogeneity and species diversity. In a study by Dodson et al. (2010), burning and thinning treatments in similar habitats, environmental heterogeneity created by treatments likely provided favorable microsites for disturbance-adapted species, thereby increasing species co-existence at the treatment-unit level. The paper goes on to say, "we found no evidence that any of the active restoration treatments reduced species richness at any scale, including community heterogeneity. In contrast, the thin/burn treatment increased community heterogeneity and colonization by new species without increasing local species extirpation. Collectively, these results suggest that few species in the frequent-fire adapted forests are negatively impacted by restoration treatments".

219.9(a)(2)(iii) Diversity of native tree species. The diversity of native species is important for ecosystem functioning. Thinning within deer winter range as provided by this amendment may occur on 5 acres of the 70 acres proposed for aspen stand treatments, and within 16 acres of the 210 proposed acres of overstory aspen treatments. This translates into approximately 7% of the total aspen stand treatments and 8% of the total aspen overstory treatments within deer winter range under the amendment in alternatives 2 and 3. There would be a long-term, moderate benefit to aspen stands by thinning and prescribed fire treatments because they would promote health and vigor of the aspen by removing competing confers. Conifer encroachment can suppress aspen sprouts and overtop and kill the aspen overstory though vegetative competition for lights and soil resources) Shepperd et al., 2001a; Jones et al., 2005). As mentioned above, thinning of conifers within aspen strands would help create a diverse age structure that could provide protection against the effects of wildfire, insects and disease, and browsing.

Thinning in deer winter range would have no effect on rare plant communities or the recovery of T&E species, conservation of species of concern, or botanical Regional Forester Sensitive Species. None of the above species or communities intersect with thinning treatments in deer winter range.

Lower Methow and Twisp River Watershed Analyses
In compliance with the watershed analyses, surveys were performed a year or more in advance prior to activities. Habitat for *Botrychium spp.* has been delineated for this project and will continued to be monitored.

Forest Service Manual
This project is in compliance with FSM 2670 in that a Biological Evaluation was prepared and the project is properly designed and mitigated to maintain viable populations of Sensitive plant

species, and does not contribute to or trend these species toward being listed as Threatened or Endangered.

This project is in compliance with FSM 2620 in that it considers the distributions of species and habitats and ensures that habitat is provided for the number and distribution of reproductive individuals needed to ensure the continued existence of a species throughout its geographic range.

3.10 Range

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Range Resource Report by L. D. McFetridge (2016), available in the project record. Reference information is contained in the full specialist report.

3.10.1 Methodology

The resource elements, indicators, and measures used to analyze and compare potential effects of the Mission Restoration on range resources are shown in Figure 97. Indicators and measures address the purpose and need and key internal issues raised during project planning.

Figure 97. Range Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Forage Availability	Understory Forage Production	Acres of forest canopy opened, improved cattle distribution	Key issue: Proposed thinning treatments will effect cattle grazing	LRMP
		Acres of soil disturbance		
Meeting Riparian Management Objectives	Changes in openings or routes providing cattle access to riparian areas	Miles of road changes that limit access to riparian areas	Key issue: Proposed thinning treatments will effect cattle grazing	LRMP S/G, ARCS S/G, Lookout Mt. AMP, Libby and Middle Methow W.A.
		Acres of commercial harvest within or adjacent to riparian reserves		

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Reduced Range Management Access	Reduced Cattle Access to Transitory Range	Miles of access lost	Key Issue: Proposed transportation changes will negatively affect range management access	LRMP
	Miles of open roads within the grazing allotment	Miles of access lost	Key Issue: Proposed transportation changes will negatively affect range management access	LRMP

Resource Indicator: Understory Forage Production
This analysis will consider the impacts of thinning treatments on understory forage production. Acres of forest canopy opened and acres of soil disturbance will be compared to existing conditions as described in the Affected Environment section. Thinning treatments would open the canopy and create a long term increase in forage production and soil disturbance caused by the thinning and soil treatment activities would create a short term reduction in forage.

Resource Indicator: Change in openings or routes providing cattle access to riparian areas
This analysis will consider the effects of proposed forest restoration activities on cattle access to riparian areas. Road system changes that would remove portions of road from riparian reserves would reduce access to the affected stream segments. The combination of opening the dense forest canopy and decommissioning roads leading to the riparian areas would change livestock access. Miles of road changes that reduce access to riparian areas and acres of proposed harvest within and adjacent to the riparian reserves will be compared to existing conditions.

Resource Indicator: Miles of accessible roads within grazing allotment (cattle access to Transitory Range).
The effects of the proposed transportation changes on cattle access to foraging areas within transitory range will be analyzed. The proposed decommissioning of roads may limit cattle travel and decrease proper grazing distribution. Miles of road proposed for decommissioning will be compared to the existing condition as described in the Affected Environment section.

Resource Indicator: Miles of open roads within the grazing allotment (range management access)
The effects of the proposed transportation changes to range management access on open roads will be analyzed. The primary concern would be directed at those roads proposed for conversion to ML1 (closed) or decommissioned, where range management access would be inhibited or prohibited, relative to current conditions. Miles of road changes that reduce range management access will be compared to existing conditions in the Affected Environment section.

Open roads with a ML2 or greater meet the minimum vehicular range management access needs within the MRP Analysis Area. Typically ML3 roads would be needed for large semi-trucks with trailers used to haul livestock. However, some ML2 roads would provide this access. ML1 (closed) roads can meet the minimum access needs for some range management activities (i.e., improvement maintenance and livestock management) but access is limited to ATV, OHV, horse, or foot travel. Often, access is very limited on ML1 roads due to impassible barricades, washouts, and debris; the access becomes prohibitive without costly clearing of down trees and other debris; even to provide ATV access.

3.10.2 Intensity Level Definitions

Type of Impact

- Adverse: Soil disturbance would reduce forage productions. Thinning treatments would increase access to riparian areas. Transportation changes would reduce range management access.
- Beneficial: The opening of the forest canopy would increase forage production. Transportation changes would lead to a decrease in access to riparian areas. There is no benefit to range management access.

Duration of Impact

- Short-term: Immediately after soil disturbance and during thinning treatments
- Long-term: Up to approximately 20 years for soil disturbance and permanently for road changes.

Intensity of Impact

- None: No impacts
- Negligible: Soil impacts would only affect the foliage with no impacts to the roots. The forest canopy would not be opened enough for any measurable effect to forage production. A change in riparian or range management access that would be so small that it would not be of any measurable consequence.
- Minor: Some soil impacts causing damage to both the foliage and roots but no plant mortality is expected. The opening of the forest canopy would be apparent with a measurable increase in forage production but with no noticeable benefit to cattle distribution. A change in riparian access that would be small and localized and with no increased risk of not meeting riparian management objectives. A change in range

management access that would be small but with some reduction in cattle distribution and management efficiency.

- Moderate: Soil impacts cause some plant mortality with damage to both foliage and roots. The opening of the forest canopy would increase forage production enough to improve cattle distribution. A change in riparian access that would be measurable and less localized. A change in range management access that would have a noticeable reduction in cattle distribution and range management efficiency.
- Major: Soil impacts would cause irreversible damage the roots of the plant causing mortality. The opening of the forest canopy opening would increase cattle distribution as much as possible. A noticeable change in riparian access that would be measurable with an increased risk of not meeting riparian management objectives. A change in range management access that would severely impact management of the grazing allotment.

3.10.3 Affected Environment

Figure 98. Range Resource Indicators and Measures for the Existing Condition

Resource Element	Resource Indicator	Measure	Alternative 3 (Units)
Forage Availability	Increase in Understory Forage Production	Acres of forest canopy opened	0 acres
		Acres of soil disturbance	0 acres
Meeting Riparian Management Objectives	Changes in openings or routes providing cattle access to riparian areas	Miles of road changes that limit access to riparian areas	0 miles
		Acres of proposed harvest within or adjacent to Riparian Reserves	0 acres
Reduced Range Management Access	Reduced Cattle Access to Transitory Range	Miles of access lost	0 miles
	Miles of open roads within the grazing allotment	Miles of access lost	0 miles

Resource Indicator: Forage Availability – Understory Forage Production

Much of the lands within the project area are forested and do not provide a substantial amount of forage for livestock. The overstory composition of many of the forest stands have produced a dense canopy with low understory vegetation production. The majority of forage is in open conifer stands, old clear cuts, south facing slopes, meadows, and areas along roads. The primary forage type within the allotment is transitory range (a temporary increase in available forage due to past timber harvest). Much of the rangeland within the allotment is dominated by

pinegrass under a conifer overstory. Most of the timbered areas support shrubs and grasses for forage in varying quantities depending on canopy closure.

Livestock use levels on understory forage

Allotment inspections, resource condition assessments, and mid and end of season monitoring are conducted on the allotment included in the project area each year.

The Lookout Mountain allotments has many designated monitoring areas (DMAs) across the allotments for monitoring forage utilization. Forage (grass) utilization standards are 45 percent in upland understory environments (pinegrass/Idaho fescue) and 55 percent in upland grasslands (bluebunch wheatgrass). Upland forage within the project area is meeting Forest Plan (USDA & USDI 1994, 1995, 2007; USDA 1989) utilization standards with the exception of a few localized high use areas that may exceed 60 percent utilization. All DMAs within the project area have been meeting allowable use standards (allowable level of forage use) over the past 10 years with few exceptions.

Grazing allotment within the project area

A large portion of the Lookout Mountain grazing allotment is located within the Analysis Area. The permitted use on the allotment is currently meeting Forest Plan standards (USDA & USDI 1994,1995, 2007; USDA 1989) and is in balance with the current level of road access and forage availability. The permitted use in the allotment is displayed in Figure 99.

Figure 99. Permitted Cattle Use in the Analysis Area

Size (acres)	Permitted use				Grazing System
	Number (cow/calf pair)	Season of Use	Head Months	AUMs*	
45,394	230	5/16 - 9/30	1127	1488	DRR*

**AUM: Animal Units Months; DRR: Deferred/Rest Rotation*

The Lookout Mountain allotment is the only allotment within the project boundary. It is currently managed under the direction of the 2013 Allotment Management Plan (AMP). This AMP implements the decision from the Libby, Little Bridge, Newby, and Poorman Allotment Environmental Assessment (LLBNP EA). The allotment consists of 45,394 acres and is located in the Buttermilk Creek, Newby Creek, Poorman Creek, Libby Creek, Alder Creek, and Twisp River drainages. The permit allows 230 cow/calf (c/c) pair to graze from May 16 through September 30 every year for a total of 1,488 Animal Unit Months (AUMs – the amount of forage required by one mature cow [1,000 Ib.] or its equivalent for one month). Nine of the fourteen pastures in the Lookout Mountain allotment fall within project area. Five pastures are in the Libby Creek drainage: Mission/Ben, Chicamun, Hornet, Elderberry, and Smith; four pastures are in the Buttermilk drainage: Shady, Buttermilk, and Scaffold; and the West pasture falls within the Twisp River drainage. The current grazing system is deferred rotation (withholding livestock to allow the forage to reach a certain stage of growth), except for the Chicamun, Hornet, and Smith pastures which are under a rest rotation (allowing rest for one year).

Roads within the project area were constructed in conjunction with intensive logging activity that started in the 1950s and were completed in the 1960s through the 1990s in conjunction with commercial timber harvest. The current grazing allotment boundaries were established in response to the development of these roads and the transitory range created by the opening of the canopy primarily through timber management which increased understory vegetation and subsequent forage for livestock (transitory range).

Resource Indicator: Change in openings or routes providing cattle access to riparian areas
There are riparian areas on the Lookout Mountain allotment within the project area where past management (prior to 2010) may have adversely affected ESA listed fish. There are several areas that did not meet Aquatic Conservation Strategy Objectives (ACSO). The current Allotment Management Plan (AMP) is designed to improve resource conditions in these areas to eliminated impacts that retard or prevent attainment of the objectives. These riparian areas are Libby Creek, Buttermilk Creek, and East Fork Buttermilk Creek. It is a requirement of the AMP to meet allowable use in these riparian areas.

Within the project area, the Lookout Mountain allotments has designated monitoring areas (DMAs) for monitoring streambank alteration and Riparian shrub use and use on riparian grasses/sedges. The DMAs are chosen to be representative of a larger stream or meadow area or the most representative upland areas. The allowable use standard for livestock caused streambank alteration is not to exceed 20% current year alteration by livestock and limit allowable use on riparian shrubs to 40% utilization and riparian grasses to 45% utilization. All DMAs within the project area have been meeting allowable use standards over the past 10 years with few exceptions.

During summer, livestock tend to be attracted to riparian zones due to water availability; higher concentrations of nutritious, palatable forage; and, if trees or shrubs are part of the system, preferable thermal conditions (Leonard et al. 1997). Cattle generally prefer grasses and forbs to woody vegetation, at least when the herbaceous vegetation is green. Some degree of moderate use of palatable herbs (primarily grasses and sedges) can occur within the riparian area without undesirable browsing of riparian shrubs and without streambank damage (Hall and Bryant 1995). In riparian areas, livestock generally do not browse woody plants if they have a sufficient supply of palatable grass (Leonard et al. 1997). The opening of the canopy in thinning units adjacent to the riparian areas would increase understory forage production. As long as a sufficient level of palatable grass is available outside of the riparian area, as discussed further below, undesirable streambank damage and browsing of riparian shrubs is unlikely.

Many of the proposed thinning units are within pastures that are grazed in the early season (May-June). The forage type within these early season pastures is predominantly bluebunch wheatgrass on the open south facing slopes and pinegrass in conifer-dominated sites. In the early season the forage preference by cattle is for bluebunch wheatgrass over pinegrass. The cattle utilize the bunchgrass habitat while cool temperatures and moist soils keep the bunch grass green and palatable. The cattle will mostly be distributed in the upland bunchgrass habitat during the early season as the upland plants have similar or higher nutritional content than the riparian forage. Also there are more upland water sources and preferable thermal conditions for

the cattle (Wyman et al. 2006). Cattle would utilize the pinegrass transitory forage within the harvest units to a much lesser extent and the existing riparian shrub densities would be maintained, because the early season timing of livestock use would favor upland forage within most of the harvest units.

Resource Indicator: Miles of accessible roads within grazing allotment (cattle access to Transitory Range).
The primary forage type within the Lookout Mountain allotment is transitory range, which are areas of temporary forage resulting from openings created by past timber harvest, prescribed fire, and wildfire. Roads serve as the dominant livestock travel paths to and from transitory range. A reduction in the road network will reduce or restrict access to transitory range.

All the roads within the project area fall exclusively within the Lookout Mountain grazing allotment. Roads are extremely important to the movement of cattle through the relatively steep rangeland within the project area. Currently, roads offer access to transitory range whereby routine and efficient travel paths have been established to guide livestock. **Figure 100** displays the miles of roads that currently occur within the Lookout Mountain allotment. Much of the rangeland within the allotment is dominated by pinegrass under a conifer overstory. Miles of road changes that reduce access to transitory range will be compared to existing conditions.

Figure 100. Current Road Miles by Management Level in the Lookout Mountain Grazing Allotment

MANAGEMENT LEVEL	MILES
1 - BASIC CUSTODIAL CARE (CLOSED)	77.25
2 - HIGH CLEARANCE VEHICLES	28.24
3 - SUITABLE FOR PASSENGER CARS	25.02
4 - MODERATE DEGREE OF USER COMFORT	3.41
Total	**133.92**

Resource Indicator: Miles of open roads within the grazing allotment (range management access)
Currently there are a total of 56.67 miles of open roads within the Lookout Mountain allotment. These roads are providing needed access by both the Forest Service and permittee to administer and manage the allotment. The current level of access is sufficient to effectively and efficiently maintain structural improvements, place salt, move cattle on and off the allotment via truck or stock trailer, and check on cattle distribution. It is common that permittees will look for cattle using motorized vehicles, then ride to gather cattle once found.

Figure 101. Current Open Road Miles by Management Level in Lookout Mountain Grazing Allotment

MANAGEMENT LEVEL	MILES
2 - HIGH CLEARANCE VEHICLES	28.24
3 - SUITABLE FOR PASSENGER CARS	25.02

MANAGEMENT LEVEL	MILES
4 - MODERATE DEGREE OF USER COMFORT	3.41
Total	**56.67**

3.10.4 Environmental Consequences

3.10.4.1 Considered, but not Analyzed in Detail

The following proposed actions will not be considered further in this analysis because they would have no measurable effect on Range Resources: rock armoring; replacing undersized culverts or installing fish culverts; beaver habitat or coarse woody debris enhancement; or creating hardened fords.

3.10.4.2 Alternative 1

3.10.4.2.1 Effects

Resource Indicator: Forage Availability – Understory Forage Production

Forest stand canopy closure would continue and the availability of understory forage would decrease slowly. The no action could result in limiting livestock use patterns and distribution. Livestock use within the project area would be more concentrated as the transitory range forage production becomes more limited and would need to be adjusted through Annual Operating Instructions if Forest Plan allowable use standards were exceeded. A minor, long-term, adverse impact is expected.

Resource Indicator: Change in openings or routes providing cattle access to riparian areas

As tree stand density increases and as snags fall and debris accumulates, there would be fewer openings and more limited access routes to riparian areas. Fuel loading would continue to increase and fire intensity would be expected to be high in the projects area. In the event of a wildfire, cattle access to the riparian area could increase, and post-fire vegetation could change to a more palatable forage type that would attract cattle, resulting in an increase in damage to streambanks from trampling and hedging of regenerated riparian shrub species. A minor to moderate, long-term, adverse impact is expected.

Resource Indicators: Miles of accessible roads within grazing allotment (cattle access to Transitory Range) and miles of open roads within the grazing allotment (range management access)

Range management road access levels would remain the same as they are currently unless modified by future, project level NEPA analysis. The transportation system would continue to provide for relatively efficient administration and permittee livestock management. Livestock would continue to be able to access remote forage by using roads that are relatively free of obstacles. No beneficial or adverse impact is expected.

3.10.4.3 Alternative 2 and 3 – Proposed Action Effects Common to Both Action Alternatives or to Alternative 2 Only

With the exception of the transportation changes, the proposed project activities are identical between Alternatives 2 and 3 and the effects for both alternatives will be described together. The transportation changes will be discussed separately under Alternative 3.

3.10.4.3.1 Effects

Figure 102 summarizes the resource indicators for Alternative 2 and Alternative 3, for non-transportation proposed actions only.

Figure 102. Range Resource Indicators and Measures for Alternative 2 and Alternative 3 (non-transportation proposed actions only)

Resource Element	Resource Indicator	Measure	Alternative 2 (Units)
Forage Availability	Increase in Understory Forage Production	Acres of forest canopy opened	9782 acres
		Acres of soil disturbance	98 acres (5% of 1933)
Meeting Riparian Management Objectives	Changes in openings or routes providing cattle access to riparian areas	Miles of road changes that limit access to riparian areas	4.41
		Acres of commercial harvest within or adjacent to Riparian Reserves	78
Reduced Range Management Access	Reduced Cattle Access to Transitory Range	Miles of access lost	31
	Miles of open roads within the grazing allotment	Miles of access lost	4.86

Resource Indicator: Forage Availability – Understory Forage Production

It is well-documented that thinning and/or removal of the forest component in dry forest ecosystems results in the stimulation of the associated understory vegetation (McConnell and Smith 1970; Riegel et al.1995; Naumburg and DeWald 1999). In general, the research indicates that productivity of understory vegetation is inversely related to tree density and directly proportional to the amount of solar radiation that reaches the understory vegetation.

Thinning treatments would open 9782 acres of the conifer overstory and dense patches of young conifers in the understory within the Lookout Mountain allotment. This would allow increased light levels to the understory as well as more soil resources available and reduced competition to understory species. Thinning and underburning activities usually reduce forage

production only during implementation. Shortly after these activities (within a season), the understory species increase, producing transitory range for livestock as described and provided for in the LRMP. A long-term, moderate, beneficial impact is expected.

Acres of Overstory and Understory Thinning Relative to the Grazing Area: Only the pastures affected by the proposed action are analyzed and listed in **Figure 103**. Relative to the total grazing area, 36% is within thinning treatment units. The Mission and Shady pastures have the bulk of the thinning treatments (50%).

Figure 103. Acres of Overstory and Understory Thinning Within the Grazing Area

Pasture Units	*Noncommercial Thin*				*Commercial Thin*					Total	Total Pasture Acres
	Plant-ation Thin	*LFR Thin out-side CTU**	*Post & Pole Thin*	*Conifer Girdling for Aspen*	*Aspen Thin*	*Dry Forest Restoration – Dwarf Mistletoe Thin*	*Dry Forest Restor-ation Thin*	*Moist Forest Thin*	*Variable Retention Regen Thin*		
Ben	103	69				1	66			239	1637
Buttermilk	243	727	40		15		45	5		1075	3003
Chicamun							224			224	3013
Elderberry		198					252			450	963
Hornet	305	666			12		55	28		1066	3613
Mission	613	1574		40	55	145	289		80	2796	6153
Scaffold	56	599								655	
Shady	362	1167		36	129	138	217	42		2091	4951
Smith		1104	5				136			1245	4067
West		101								101	
Total	1703	6025	45	76	210	284	1284	75	80	9782	27400

**CTU: Commercial Thin Units*

There are a total of 1933 acres of commercial thinning units within the affected grazing allotment. The area of commercial harvest is small relative to the grazing area (7%; Figure 103). There would be 29% of the total affected pasture area within non-commercial thinning units and 36% within all thinning units. With the affected rangeland having 36% percent of the area within the thinning units, it is expected that there will be a long-term, moderate, beneficial impact to understory forage production. The short-term effect on the current available forage would be a slight reduction relative to the total available forage and the long-term effect of increase transitory forage would be expected to increase proportionally to the amount of acres treated that open the canopy. It is well-documented that thinning and/or removal of the forest component in dry forest ecosystems results in the stimulation of the associated understory component (McConnell and Smith 1970; Riegel et al.1995; Naumburg and DeWald 1999). In general, the research indicates that productivity of understory vegetation is inversely related to tree density and directly proportional to the amount of solar radiation that reaches the understory vegetation. The same research indicates that increased productivity is positively correlated with larger trees and wider spacing. The effect of increased plant productivity is an

increase in forage and browse that is available for grazing by permitted livestock. This transitory range would increase the amount of available forage within the grazing allotment and would improve livestock distribution. Under current stocking rates, the additional forage would distribute livestock use patterns more evenly reducing overall utilization levels across the grazing allotment. Additionally, with improved livestock distribution, it is expected that grazing would have a negligible effect on the rate and pattern of the understory vegetation response to a more open canopy and the basic productivity of the land would be protected for wildlife and other resources. Neither the current Lookout Mountain AMP nor this project would provide for an increase in livestock numbers. There will not be an increase in AUMs (Animal Unit Months) permitted to graze.

A total of 210 acres of commercial thinning and 76 acres of noncommercial thinning are proposed to promote the restoration of aspen stands. The recent grazing Allotment Management Plan revision Environmental Assessment (LLBNP EA 2011) analyzed the effects of cattle grazing on aspen which included all of the Mission planning area. The analysis found that most, if not all, of the aspen stands were utilized by cattle for grazing and loafing, but the grazing system [2011] appeared to be conducive to allowing aspen stands to regenerate through sucker sprouting. The stands appeared to be healthy and were limited more by conifer shading and disease than by ungulate browsing. Hadfield and Magelssen (2004) found that aspen stands on the Okanogan and Wenatchee National Forests were commonly browsed by cattle and deer, but not severe enough to prevent aspen sprouts from growing into larger stem sizes. Some of the stands they reviewed were in the Mission project area. Cattle are using these stands but do not appear to be detrimentally browsing the suckers to the point of preventing stand development. (Hadfield and Magelssen 2004; LLBNP EA 2011) As discussed above, thinning treatments would increase the productivity and distribution of understory vegetation. Grazing use levels across the project area are currently less than when the 2011 grazing analysis was completed and are meeting allowable use standards. It is expected that the relatively large scale thinning treatments would increase cattle distribution and further reduce cattle impacts to aspen stands.

Effects of Underburning on Understory Forage Production: There would be 7363 acres of underburing. Some of the areas within the Underburning units are not grazed due to slope and distance from water. Typically range greater than 30% slope, and more than ½ mile from water is not classified as capable range. As a result, the burns would have little effect on livestock distribution patterns within these areas. Within capable range, prescribed burning has long-term beneficial effects. Typically, understory species associated with dry forest plant communities are either tolerant of or enhanced by low and moderate intensity fire (Agee 1993). Prescribed fire would have a positive effect on the overall vigor of the forage and would help maintain a more open structure in most of the timber stands within the analysis area, improving the potential to increase forage production in the understory. Where there is cattle accessibility, the improved forage would help draw cattle away from riparian areas. A minor, long-term, beneficial impact is expected.

The Effect of Soil Disturbance on Understory Forage Production: Winter operations are required in some units to minimize soil impacts unless the purchaser can present a plan of for no more

than 2% detrimental soil conditions per unit. Ground based winter harvest on frozen soils has shown to result in less detrimental soil disturbance as compared to summer harvest (Reeves et al. 2011). There would be virtually no soil disturbance that would be detrimental to understory forage under winter logging and a short-term, negligible to no adverse impact is expected.
A total of 455 acres of soil treatments are proposed within the grazing units. The bulk of these treatments are in the bottom of Ben, Chicamun, and Elderberry canyons and in the bottom of Hornet Draw. These units are associated with the flat canyon bottoms where cattle commonly loaf. Forage production is generally low within the treatment units where the vegetation is conifer and shrub dominated and the forage tends to be patchy and in relatively small pockets. The bulk of the primary forage is on the toe slopes of the canyons above the valley bottoms. It is not expected that the treatments would result in a measureable short term reduction in forage production, however, where overstory thinning and soil treatments overlap, it is expected that there would be a long term increase in understory forage as the vegetation responds to improved soil structure and light levels. A negligible, short-term, adverse impact is expected.

Figure 104. Acres of Soil Treatments by Pasture Units

Pasture Units	Soil Treatment Acres
BEN	115.96
CHICAMUN	104.45
ELDERBERRY	92.15
HORNET	82.75
MISSION	15.31
SMITH	44.80
Total	*455.42*

Resource Indicator: Change in openings or routes providing cattle access to riparian areas
When riparian areas lie within overstocked forest stands with dense canopies, cattle access may be limited by the physical barrier that the vegetation creates or cattle simply are not attracted the riparian area as it may offer little or no forage opportunities. Cattle will avoid these areas in favor of open forest stands, south facing slopes, meadows, and areas along roads. Opening forest stands within riparian reserves may increase cattle access to the riparian areas and may limit meeting Riparian Management Objectives. Conversely, opening forest stands in the uplands outside of riparian reserves would increase available forage and would likely draw cattle away from the riparian area. Additionally, the roads leading to riparian areas can serve as efficient cattle travel paths and facilitate livestock access. Road system changes that would remove portions of road from riparian reserves would reduce access to the affected stream segments. The combination of opening the dense forest canopy and decommissioning roads leading to the riparian areas would change livestock access. A minor, short-term, adverse impact is expected.

There is currently a need to reduce the level of livestock use in some riparian areas within the project area. Approximately 78 acres of proposed Commercial harvest units lie within the outer

edge of Riparian Reserves. In order to meet ACS Objectives, no-harvest buffers of 50 to 100 feet would be established along intermittent and fish bearing streams. Also about 60 percent of the harvest in Riparian Reserves would be done in the winter and occur over frozen ground. All harvest activities within Riparian Reserves would be done with the objective of attaining riparian management objectives and ensure that Forest Plan and ACS objectives are met. By attaining these objectives and meeting these standards and guidelines, it is expected that there would be a short-term, negligible, adverse impact.

Additionally, some of the riparian areas within the project area are intermittent headwater streams. Livestock would not be attracted to these areas for water, because these streams typically do not have surface water during the summer grazing season. Most of the perennial streams have dense populations of riparian shrubs that stabilize the banks and limit livestock access. Some of the perennial streams like Buttermilk and upper Libby creeks are high gradient, cascading, and boulder with very limited cattle access. Project design details and mitigation measures would help prevent additional livestock impacts to riparian areas.

The soil disturbed by project activities in harvest units adjacent to the perennial streams would be seeded with grasses which would help draw cattle away from perennial riparian areas. All perennial streams would have a no-cut buffer zone from 50 to 100 feet or more. The accumulation of down, dead material in the buffer zone would impede cattle access. Large accumulations of down dead material have led to decreased access to riparian areas in other streams on Methow Valley Ranger District and continue to be a benefit in protecting the riparian habitat.

Opening the forest stands with the proposed commercial thinning treatments would increase available forage outside of riparian areas. The number of cattle that access riparian areas may decrease, because grazing distribution patterns would improve in the uplands. Even though the more open stands could allow easier access to riparian areas, no additional use of riparian areas is expected because cattle distribution would be improved and direct access to streams would be restricted by riparian vegetation along streams.

Water developments in the upland areas that lack water are often a key factor in reducing livestock concentrations in riparian areas (Wyman et al 2006). The permittee would continue to maintain the upland water developments. Range management practices such as riding; proper salting, and maintaining allotment fences would also reduce the potential for additional livestock impacts to riparian areas.

Miles of road changes that limit or increase access to riparian areas: During the hot summer months, cattle prefer the quality, diversity, and succulence of the vegetation found in riparian zones. Slopes less than 35% are preferred by cattle and when forage rich riparian zones are available at the bottom of narrow canyons, they are attractive to cattle and concentrate their activities when upland forage becomes rank or dry (Bryant 1982; Wyman et al. 2006). There are a total of 4.41 miles of road that currently provides cattle trailing access to riparian areas that would be decommissioned under Alternatives 2 and 3. Both action alternatives would have a similar effect in limiting cattle with the exception of the 4342-300 road in Alternative 3. In Alternative 3 all three miles of the 4342-300 road (Chicamun Canyon road) would be

decommissioned but only the last .63 miles would be decommissioned in Alternative 2. Cattle currently concentrate travel on the Chicamun Canyon road to avoid more difficult movement through the vegetated off-road areas along the stream and typically only travel to the stream in the most accessible areas. Under Alternative 3, more cattle travel would shift off the altered Chicamun Canyon road surface and on to the more accessible areas between the road and the creek, which may be within the riparian area, resulting in an increase in cattle impacts. With the exception of the Chicamun Canyon road, Alternatives 2 and 3 would have similar trailing access to the riparian areas. The Range Resource report (McFetridge 2016) has additional information on riparian roads closures.

Coarse Woody Debris (CWD) Enhancement: The felling conifers into streams would not only help to restore fish habitat but an added benefit would be that the trees would help to limit cattle access to the stream; especially by restricting trailing up and down the stream. All of the streams proposed for CWD enhancement would benefit from less cattle access both as habitat protection and to reduce the potential of physical impact to fish.

Effects of Ladder Fuels Reduction (specific to riparian areas): Ladder Fuels Reduction (LFR) would not increase livestock access to riparian areas. Aquatic resources design criteria would not permit LFR anywhere inside Riparian Reserves (10 ft. buffer for intermittent and 50 ft. buffer for perennial streams). This would prevent LFR treatments from getting close enough to stream channels to create new openings to the riparian areas for cattle access with no impacts expected.

Effects of Underburning: The proposed action would reduce the fuel loading adjacent to riparian areas and within some Riparian Reserves. Approximately 739 acres of proposed fuels treatments lie within Riparian Reserves. All treatments within Riparian Reserves must not prevent the attainment of Aquatic Conservations Strategy Objectives. The design criteria would be no active lighting within 25 feet of intermittent streams and 100 feet of perennial streams with a resource objective of maintaining 95% survival of over story trees, 66% of the understory, and 50% of the ground cover. If these objectives cannot be met, the area would be excluded. The effect of underburnng would be that most of the riparian obligate shrub vegetation would remain intact.

There would be no dozer fireline and hand fireline will not be constructed within Riparian Reserves except for the purpose of controlling backing fire and outside of approximately 100 feet of a stream where needed to keep the fire out of the inner gorge. The construction of fireline would create cattle access paths along riparian areas but with the implementation of the design criteria, a short term, negligible, adverse impact is expected. Treatment of forest stands adjacent to riparian vegetation would reduce the severity of effects from wildfire. Proposed vegetation treatments that provide for the greatest potential to reduce the severity of wildfires and consequently sustain the dense riparian shrub community would best maintain the current limited cattle access.

The timing of the burning relating to scheduled grazing rotations could require in the intensity, timing and duration of livestock use within the affected pastures. These adjustments would be incorporated into annual operating instructions to meet resource protection standards.

3.10.4.4 Alternative 3 – Effects Unique to Alternative 3

3.10.4.4.1 Effects

Alternative 3 includes additional road closures which would reduce range management access. A summary of these changes are in **Figure 105**.

Figure 105. Range Resource Indicators and Measures for Proposed Actions Unique to Alternative 3.

Resource Element	Resource Indicator	Measure	Alternative 3
Meeting Riparian Management Objectives	Changes in openings or routes providing cattle access to riparian areas	Miles of road changes that limit access to riparian areas	6.78 miles
Reduced Range Management Access	Reduced Cattle Access to Transitory Range	Miles of access lost	54 miles
	Miles of open roads within the grazing allotment	Miles of access lost	67 miles

Resource Indicator: Miles of accessible roads within grazing allotment (cattle access to Transitory Range).

The implementation of either of the two action alternatives would result in less cattle access to foraging areas and reduce grazing distribution throughout the grazing allotment. Of the 134 total miles of road within the grazing allotments, approximately 31 miles would be decommissioned under Alternative 2 and 54 miles would be decommissioned under Alternative 3. (This does not include Temporary roads that would be decommissioned)

After road decommissioning, access on roads that previously provided routes to foraging areas through rough, steep, or densely forested terrain may be limited to the extent of making that forage unavailable. Not all the roads proposed for decommissioning currently provide access to foraging areas. Those roads to be decommissioned that are currently used extensively by cattle would be designed to provide cattle access by leaving a trail-space along the edge of the decommissioned road. These project design criteria would be applied to 1.6 miles under both action alternatives, reducing impact to livestock grazing. Overall, there would be a 23% reduction in roads available for livestock access to transitory range for Alternative 2 and a 40% reduction for Alternative 3. A long-term, minor to moderate, adverse impact is expected for Alternative 2 and a long-term, moderate to major, adverse impact is expected for Alternative 3.

Resource Indicator: Miles of open roads within the grazing allotment (range management access)

The primary concern would be directed at those roads proposed for conversion to ML1 (closed) or decommissioned, where range management access would be inhibited or prohibited, relative to current conditions. The District conferred with grazing allotment permittees to determine which roads are essential for continued range management. When such roads would be closed

or decommissioned, design features would be incorporated to allow for continued access. Therefore, the current 57 miles of open road (ML 2-4) would be reduced to 52 miles for Alternative 2 and 35.4 miles for Alternative 3 (ML2-4 – 4.86 and 21.58 miles)

Design criteria for decommissioned roads was previously described. For road closures, Forest Service manual 7731 Road Operation describes that roads can be closed to the public yet used for administrative uses as ML2 Administrative Use roads. Existing and proposed ML1 roads needing ATV/UTV access for maintenance of stock tanks or other legitimate reasons would be converted to a ML2 Administrative Use designation. A total of 13.15 miles of ML1 road would be designated as ML2 Administrative Use roads for alternative 2 and 4.75 miles for alternative 3. Only the roads with proposed changes in maintenance levels that restrict range access are displayed in the following table. With these design criteria, the effects of the proposed road closures and decommissioning on range management would be greatly reduced with the effects of Alternative 3 having a much higher impact on reducing range management access than Alternative 2. It is expected that Alternative 2 would have a minor to moderate, long-term, adverse impact and Alternative 3 would have a moderate, long-term, adverse impact. Refer to Appendix B for a list of these roads and to the Range Resource Report (McFetridge 2016) for specific roads closing within grazing allotment.

There are roads where access is critical for fence and water development maintenance, livestock management, and administrative use. **Figure 106** lists over 12 miles of roads that are proposed for decommissioning under Alternative 3 that are the most critical for allotment management and administration. The roughened surface of decommissioned roads greatly limits livestock trailing. Livestock would create new trails on the decommissioned road or create new off-road trails. Locating and gathering cattle would be more difficult. Administrative access and all management access would be limited to foot travel or limited horse travel which would greatly reduce the efficiency for livestock management and administration.

Figure 106. Roads Critical for Allotment Management and Administration under Alternative 3

Road Number	Miles
4300550	1.96
4300553	1.58
4300556	0.80
4300560	2.29
4300615	0.72
4300615	0.44
4300645	1.30
4340785	0.70
4342300	2.39
Total	**12.18**

3.10.4.4.2 Cumulative Effects

Spatial and Temporal Context for Effects Analysis

This cumulative effects analysis considers effects of past, present and reasonably foreseeable future actions within the analysis area. The geographic boundary for this cumulative effects analysis is the entire analysis area boundary and the temporal boundary is from about 50 years in the past when the development of roads for timber harvest created transitory range and easy range management access to 10 years in the future, the period of time needed for grazing management to adjust to the proposed transportation changes.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

Past Actions: Roads were constructed in conjunction with intensive logging activity that started in the 1950s and ended in the 1990s. The current grazing allotment boundaries were established in response to the development of these roads and the transitory range created by timber harvest and opening of the canopy. Past prescribed burning and fire suppression activities have slightly increased livestock access to foraging areas with the creation of hand and dozer fire lines.

Present Actions: The implementation of the 2013 Lookout Mountain Allotment Management Plan (AMP) include actions such as new fence construction and more management flexibility built into the grazing strategies with requirements to meet riparian management objectives. Livestock numbers will remain consistent with the current AMP.

There would be weed control along roads and in some off road areas under the existing Integrated Weed Management decisions. See the Invasive Plant section for details.

Active fire suppression will continue in the project area because of its proximity to private lands and associated developments. Suppression activities have contributed to changing the natural fire cycle from frequent, low-intensity fires that kept the forest structure more open to much less frequent fires that have allowed trees to become denser, which has reduced the quality and availability of transitory range.

Reasonably Foreseeable Future Actions: Livestock grazing would continue. Range management techniques—such as riding, adjusting intensity, proper salting, and maintaining water developments and fences—would continue to help meet riparian objectives and to obtain a more uniform distribution of use on the allotments.

The implementation of the *Okanogan-Wenatchee National Forest Forestwide Site-Specific Invasive Species Treatment EIS* would increase the number of weed treatment options available and increase the area of infested lands that may be treated within the project area. Early detection, rapid response to newly discovered infestations would increase treatment effectiveness and reduce the potential for spread of new populations. This future action would help maintain a sustained yield of desirable forage plants and would reduce the spread of invasive plants from livestock grazing.

Resource Element: Forage Availability

Grazing and implementation of the 2013 Allotment Management Plan (AMP) would have a continued effect on understory vegetation but would not change forage availability. Noxious

weed treatments would continue and would help to increase the amount of forage available to cattle.

Resource Element: Meeting Riparian Management Objectives
Grazing and implementation of the AMP would have a continued effect on riparian areas but would not result in a change to the resource indicators. Noxious weed treatments would continue and would help to restore native plant communities in riparian areas.

Summary of Cumulative Impacts
The cumulative effect of past, present, and reasonably foreseeable future actions and the proposed thinning treatments and transportation changes in Alternatives 2 and 3 would have both adverse and beneficial impacts to Range Resources.

Forage Availability - Understory Forage Production: The continued implementation of the 2013 Lookout Mountain AMP, with grazing strategies designed to alternate the season of use to provide for proper pasture rest or deferment, would help to sustain understory forage production. With the implementation of the Invasive Treatment EIS, more weed management options would be available to control invasive plants in the confer understory. Controlling weeds would allow the establishment and sustainability of desirable plants and reduce the potential of spread from livestock grazing. Active fire suppression, when successful in keeping fires small, would have a short-term benefit to the understory forage but a reduction in the long-term benefit of overstory removal which would increase understory vegetation. A long-term, moderate, beneficial, impact is expected

Meeting Riparian Management Objectives: The continued implementation of the 2013 Lookout Mountain AMP with riparian management requirements would help reduce impacts to riparian areas. Continued maintenance of fences constructed to eliminate cattle access to streams in early season would have a major beneficial impact. With the implementation of the Invasive Treatment EIS, more weed management options would be available to control invasive plants in the uplands which would sustain or increase upland vegetation and help draw cattle away from riparian areas. Active fire suppression, when successful in keep the fires small, would reduce the potential for wildfire to consume the riparian vegetation creating more open cattle access. The suppression of fires will continue to limit the availability of long-term transitory range but will increase the likelihood that riparian areas will remain intact. A long-term, moderate, beneficial, impact is expected.

Reduced Range Management Access: The cumulative effect of past, present, and reasonably foreseeable future actions would have a minor impact on range management access. A minor, long-term, adverse impact is expected.

3.10.4.5 Summary of Effects

Figure 107. Range Resource Indicators and Measures Summary for All Alternatives

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)	Alternative 2	Alternative 3
Forage Availability	Increase in Understory Forage Production	Acres of forest canopy opened	0 acres	9782 acres	9782 acres
		Acres of soil disturbance	0 acres	98 acres (5% of 1933 total)	98 acres (5% of 1933 total)
Meeting Riparian Management Objectives	Changes in openings or routes providing cattle access to riparian areas	Miles of road changes that limit access to riparian areas	0 miles	4.41	6.78
		Acres of commercial harvest within or adjacent to Riparian Reserves	0 acres	78	78
Reduced Range Management Access	Reduced Cattle Access to Transitory Range	Miles of access lost	0 miles	31.64	67.26
	Miles of open roads within the grazing allotment	Miles of access lost	0 miles	4.86	21.58

Forage Availability - Understory Forage Production: Alternative 1 would continue the trend of closed canopy forest stands and the availability of understory forage would continue to decrease slowly limiting livestock use patterns and distribution. Livestock use within the project area would be more concentrated in areas of open access and productive forage. Range management road access would remain relatively the same and access would continue to be provided for relatively efficient administration and permittee livestock management.

Alternative 2 and 3 would have a short-term decrease in available forage disturbed by ground-based harvest systems (2-3 years). In the long term (approximately 20 years), with implementation of design criteria and weed management, transitory forage production would increase, improving livestock distribution and reducing riparian impacts. Thinning treatments would produce over 9000 acres of transitory range by opening the conifer overstory as well as dense patches of young conifers in the understory. Transitory range would continue to fluctuate. As time passes, the increase in available transitory forage would be reduced as the tree canopy closes. Shrubs, herbs and grasses would become less abundant due to the

corresponding increase in canopy cover and associated increased shading (McConnell and Smith 1970; Host 1988; Naumburg and DeWald 1999). The average transitory range duration for an average conifer stand in the Northwest area is approximately 20 years (Baumgartner 1987).

Meeting Riparian Management Objectives: Alternative 1 would continue the trend of increased forest stand density and more large woody debris within the riparian areas resulting in fewer openings and more limited cattle access routes. Fuel loading would continue to increase with a higher risk of wildfire within the riparian areas leading to an increase in cattle access.

Alternatives 2 and 3 would have no-harvest buffers combined with winter logging along Riparian Reserves which would be beneficial in attaining riparian management objectives. The soil disturbed by project activities in harvest units adjacent to the perennial streams would be seeded with grasses which would help draw cattle away from perennial riparian areas. Opening the forest stands would increase available forage outside of riparian areas. The permittee would continue to maintain the upland water developments. Range management practices such as riding; proper salting, and maintaining allotment fences would also reduce the potential for additional livestock impacts to riparian areas.

Also under Alternative 2 and 3, road system changes that would remove portions of road from riparian reserves would reduce access to the affected stream segments. The combination of opening the dense forest canopy and decommissioning roads leading to the riparian areas would reduce livestock access to riparian areas with alternative 3 having the greatest benefit. Coarse Woody Debris Enhancement would have an added benefit of limiting cattle access to the stream. The design criteria for underburning would restrict active lighting near riparian areas and sustain the riparian vegetation. Allotment management would continue to meet allowable use standards on the allotment and range management practices would continue to be implemented to meet riparian objectives.

Reduced Range Management Access: Under Alternative 1, the transportation system would continue to provide for relatively efficient administration and permittee livestock management. Livestock would continue to be able to access remote forage by using roads that are relatively free of obstacles.

Under Alternatives 2 and 3, range management access would decrease in the long term (approximately 20 years). With implementation of road closure and decommissioning designs to maintain OHV access, impacts to range management would be minimized. Livestock access to important forage would be maintained, and impacts of past road construction near riparian areas would be reversed through decommissioning. Alternative 3 would have the highest impact on reducing range management access. Management access would be reduced with the implementation of the action alternatives, but management adjustments would be made through the continued implementation of the Allotment Management Plan.

Proposed changes in road maintenance levels that would result in road closures or decommissioning would reduce the efficiency of administration and management but effective management would be retained by authorized OHV access on ML2- Administrative Use roads

and travel access by horseback. Maintenance costs associated with the clearing of down trees and other debris on closed and decommissioned roads would further reduce management efficiency. However, the impact of the action alternatives would be a relatively low reduction in access across the allotment. It is expected that the implementation of Alternatives 2 and 3 would still provide for the effective management of the grazing allotments for the affected permittees and the District.

3.10.5 Consistency Statement

Alternatives 2 and 3 would be compliant with the Okanogan National Forest Plan standards and guidelines for achieving range management objectives and Northwest Forest Plan Standards and Guidelines for management in riparian areas. Management objectives would be met to protect rangeland resources and continue the management of the affected grazing Allotment while providing for forest health.

Forest Plan Amendment Effects on Substantive Provisions

To meet Purpose and Needs #2, #3, #4 and #6 identified in Chapter 1 of the EA, vegetation management through thinning would reduce deer winter range cover below Okanogan National Forest Land Resource Management Plan Standard and Guidelines MA14-6A and MA26-6A, requiring a project-specific amendment. The 2012 Planning Rule as amended (36 CFR 219) requires consideration of how such an amendment would affect substantive provisions identified in the Planning Rule. With respect to range, the following substantive provisions would be affected by the proposed amendment:

219.8(b)(2) Multiple uses that contribute to local and regional economies in a sustainable manner. Up to 746 acres of proposed thinning would occur as a result of this amendment under Alternatives 2 and 3 and cause a beneficial, long-term, moderate effect on sustainable range use because it would promote a more open stand structure and increase understory forage that would be available as transitory range. The additional forage would distribute livestock use patterns more evenly, reducing overall utilization levels across the grazing allotment. With improved livestock distribution, it is expected that grazing would have a negligible effect on the rate and pattern of the understory vegetation response to a more open canopy and the basic productivity of the land would be protected for wildlife and other resources.

3.11 Invasive Species

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Invasive Species Resource Report by L. D. McFetridge (2016), available in the project record. Reference information is contained in the full specialist report.

3.11.1 Methodology

The resource elements, indicators, and measures used to analyze and compare potential effects of the Mission Restoration on invasive species are shown in Figure 108. Indicators and measures address the purpose and need and key internal issues raised during project planning.

Figure 108. Invasive Species Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Invasive Plant Spread	Spread of existing infestations	Acres of Invasive Plants within Treatment Units	Key Issue: Proposed project activities will effect invasive plants	USDA 2005a Goal 1 ONF LRMP S&G 12-1 USDA FS (2004) Element 3
		Miles of road infested with Invasive Plants affected by Proposed Road Changes		
Invasive Plant Prevention	Introduction and Establishment of New Infestations	Acres of soil disturbance	Key Issue: Proposed project activities will effect invasive plants	USDA 2005a Goal 2, Standard 1,2,3,7,8,13 ONF LRMP S&G 12-3 USDA FS (2004) Element 1
		Miles of road closures		

The Resource Indicators are the establishment of new introductions and the spread of existing infestations. The risk of noxious weed introduction and spread is estimated by assuming that prevention management will be implemented through the project design criteria and mitigation measures. The introduction and establishment of invasive plants is proportional to the area of disturbance and the spread of invasive plants is generally proportional to area of existing weeds disturbed by project activities. For the purposes of this analysis, "disturbance" includes: 1) exposed mineral soil, 2) reduction of competing vegetation, and 3) increase of light levels through the opening of the canopy. For this project, thinning treatments, underburning, and transportation system changes would cause at least some level of disturbance.

Gross Acres/Infested Acres: Most of the acreages used in this analysis are *gross acres* where areas are delineated by the outer perimeter of the weed infestation and may contain large areas that are not currently occupied by weeds. Multiple species can occur on a site; therefore some overlap in total gross acres may occur. Infested Area acres are defined differently, by the canopy cover of the plants, excluding areas not infested (North American Weed Management Association 2002). Field data collected on the Methow Valley Ranger District has shown that the District infestation area is 6% (recorded in the Forest Service Natural Resource Information System) of the gross area and is typical for the weed populations within the project area.

Resource Indicator: Spread of existing infestations
Existing invasive plant population are susceptible to being spread by project activities and especially by project equipment. Acres of Invasive Plants within treatment units and miles of road infested with invasive plants affected by proposed road changes will be compared to the existing condition. Also changes in potential risk of spread of existing populations by general vehicle traffic will be compared for open and closed roads for each alternative as well as how the changes will effect treatment access.

Resource Indicator: Introduction and Establishment of New Infestations
Vehicles and transportation corridors are considered to be primary vectors for the movement of invasive plant species. Project activity units currently free of invasive plants would be susceptible to new weed infestations due to the current existence of invasive plants within the analysis area as well as Potential Invaders on adjacent Federal, State and private lands. Acres of soil disturbance and the miles of road to be closed will be compared to the existing condition.

3.11.2 Intensity Level Definitions

Type of Impact

- Adverse: Increases invasive plant spread or introduces and establishes new infestations
- Beneficial: Reduces the potential for invasive plant spread and new introduction and establishment

Duration of Impact

- Short-term: Within the first growing season after project activities.
- Long-term: Up to approximately 20 years post-treatment.

Intensity of Impact

- None: No impact on invasive plant spread and new introduction and establishment
- Negligible: A change in invasive plant spread and new introduction and establishment would be so small that it would not be of any measurable consequence.
- Minor: A change in invasive plant spread and new introduction and establishment would be small and much localized.
- Moderate: A change in invasive plant spread and new introduction and establishment would be measurable and wider spread with some changes in the composition of desirable vegetation. The implementation of the design criteria would limit changes in composition of desirable vegetation.
- Major: A noticeable change in invasive plant spread and new introduction and establishment resulting in severe adverse impacts. Effects to invasive plants would be measurable, widespread, and longer term with substantial changes in the composition of the desirable vegetation beyond the expected prevention benefits of implementing the design criteria.

3.11.3 Affected Environment

Figure 109. Invasive Species Resource Indicators and Existing Conditions (Alternative 1)

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
Invasive Plant Spread	Spread of existing infestations	Acres of Invasive Plants	243.13 acres
		Miles of road infested with Invasive Plants	62.38

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
Invasive Plant Prevention	Introduction and Establishment of New Infestations	Acres of soil disturbance	0 acres
		Miles of road closures	0 miles

Resource Indicator: Spread of existing infestations
Invasive plant populations within the project area are primarily associated with roads and the population densities are very low in the closed canopy understory of the proposed thinning treatment units. Weeds are also associated with old harvest activities as well as historic grazing. Few populations are present in undisturbed off-road areas where the highly competitive native plant communities impede the establishment of invasive plants.

Recent invasive plant inventories have occurred over most of the project area that were surveyed included known populations of noxious weeds, roads, areas of more recent disturbance and preferential habitats for invasive species. The Natural Resource Information System (NRIS) Database was used to determine approximate acreage of documented infestations.

Invasive plant populations in the project area fall into three primary categories. These categories are used to prioritize invasive species for inventory and treatment:

1. *Established Invaders* are those species whose population levels and distribution are such that seed production cannot be prevented.
2. *New Invaders* are invasive plant species that occur sporadically on the Forest and that may be controlled by preventing seed production and early treatment.
3. *Potential Invaders* are invasive plants that occur on lands adjacent to the project area but have not been documented on lands administrated by the Forest; however, the potential for infestation is imminent.

Figure 110 lists new and potential invaders found within the Mission Restoration project area. Characteristics of these species are described in the Invasive Species Resource Report (McFetridge 2016). Characteristics of these species are described in Appendix A in the Invasive Species Resource Report project file.

Figure 110. Established, New and Potential Invaders Within or Adjacent to the Project Area

Established Invaders	New Invaders within project area	Potential Invaders

Bulbous bluegrass	Baby's Breath	Bohemian knotweed
Bull thistle	Common burdock	Common tansy
Canada thistle	Houndstongue	Dalmatian toadflax
Cheatgrass	Oxeye daisy	Kochia
Curly dock	St. Johnswort	Orange hawkweed
Dandelion	Sulfur cinquefoil	Russian knapweed
Diffuse knapweed	Whitetop	Scotch thistle
Common mullein		

Invasive plant information for the project area has been conducted through the Okanogan-Wenatchee Forest-wide Invasive Plant draft EIS analysis and through recent inventories.

Figure 111. Invasive Plant Sites within the Mission Project Area

Invasive Plant	Gross Acres	Number of Sites
Baby's breath	1.25	1
St. Johnswort	2.33	4
Diffuse knapweed	224	20
Houndstongue	2.14	1
Common burdock	0.25	1
Oxeye daisy	5.42	3
Sulphur cinquefoil	3.63	2
Whitetop	4.11	4
Total	*243.13*	*36*

Established Invaders: Seven Established Invaders occur throughout the project area: *Cirsium vulgare* (bull thistle), *Verbascum thapsus* (common mullein), *Centaurea diffusa* (diffuse knapweed), *Poa bulbosa* (bulbous bluegrass), *Taraxacum officinale* (dandelion), *Bromus tectorum (cheatgrass)*, *Rumex crispus* (Curly dock), and to a lesser extent, *Cirsium arvense* (Canada thistle). The lower priority established invaders are fairly widespread within disturbed areas in the project area and are so extensive Forest wide that they are not generally inventoried. The weed presence within the analysis area is primarily diffuse knapweed. Diffuse knapweed is the only Established Invader that has been inventoried and analyzed in this project, however not all populations have been mapped. It has invaded the open off-road grasslands areas with some dense populations. Small patches may be found within the restoration treatment units, however populations are very low in the dense conifer understory. Although well established locally, it is a state listed Class B noxious weed. It is not continuous; it occurs as scattered individuals and in in some dense patches. Common mullein and bull thistle are less invasive and persistent than New Invaders. They quickly invade disturbed soil but generally do not out-compete most desirable vegetation and diminish over time. Similarly, Curly doc can dominate disturbed areas in the forest understory, but generally do not

outcompete native vegetation. Dandelion is well-established on some of the roadsides and on closed roads. Cheatgrass is present in patches throughout the project area and there are a few small Canada thistle sites.

New Invaders: New Invader species do occur within the project area but this area of the Methow Valley Ranger District is relatively free of New Invaders. Most of the new invader infestations within the project area are very small with populations less than 1. There are only 19 acres of New Invaders within the project area. Sulfur cinquefoil is established in patches along roads in the lower Ben Canyon and Mission Pond area. There is a relatively large oxeye daisy population along the 300 road in lower Chicamun Canyon and smaller populations in upper Chicamun and lower Hornet Draw. There is only one known population of houndstongue in the project just east of Hornet Draw. This site it virtually eradicated but there are well established populations on private and DNR land in the lower Libby Creek area. Common Burdock, Whitetop, St. Johnswort, and Baby's breath make up just a few small patches.

Potential Invaders: Of the potential Invaders not yet on National Forest System land, Bohemian knotweed (more commonly called Japanese knotweed or Mexican Bamboo) is the most difficult to control. It has a high potential to infest the project area, because there is a well-established patch in the Lower Twisp River area and several well established patches in the mid Methow Valley. There are populations of Dalmatian toadflax on private land throughout the Methow Valley with the closet populations in the Gold Creek area. Kochia is prevalent along roadsides and waist areas in the valley bottom. There was a population of orange hawkweed on private land near the confluence of Buttermilk Creek and the Twisp River – current status is unknown. Russian knapweed can be found in patches in the valley bottom and Scotch thistle, although very invasive, is still very limited in its distribution in the Methow Valley. The project area is relatively free of the New Invader weeds listed above, however there are relatively large populations of whitetop, houndstongue, and Baby's breath on non-Forest land in the Lower Libby Creek area with a high potential to spread onto Forest land.

Integrated weed management will continue within the project area. No new herbicide treatment will be proposed with this project. All weed treatments have been approved under the 2000 Weed EA Decision Notices and will continue to be treated with herbicide as needed. Only the Buttermilk and Twisp river portion of the project area are covered under the 2000 Weed EA. Currently no herbicide treatment is located within the Libby watershed although there is some manual treatment of the new invader weeds. Bio control agents have been well established on diffuse knapweed in the Libby Creek area. The seed eating weevil, larinus minutus continues to retard the knapweed populations with some rather dramatic reductions in density on some years. The knapweed populations swing depending on the weevil populations.

Invasive Plant Infestations on Roads within the Mission Project Area: Of the total 234 miles of road within the project area, approximately 62 miles are infested with invasive plants. These weed populations are mostly confined to the roadsides and with the exception of diffuse knapweed, generally occur in relatively small patches. Roadside populations may be dense in patches but are often very low with just a few scattered plants. **Figure 112** shows the existing invasive plant presence on the current road by weed species.

Figure 112. Miles of Road Infested with Invasive Plants

Maintenance Level	Baby's breath	St. Johns wort	Diffuse knapweed	Oxeye daisy	Sulphur cinquefoil	White top	Total
1 - BASIC CARE (CLOSED)		0.06	20.55	0.07		0.07	20.75
2 - HIGH CLEARANCE VEHICLES		0.16	17.17	0.22	0.08	0.01	17.65
3 - SUITABLE FOR CARS	0.07		21.09		0.10		21.25
4 - MODERATE USER COMFORT			2.73				2.73
Total	*0.07*	*0.21*	*61.54*	*0.30*	*0.18*	*0.08*	*62.38*

Resource Indicator: Introduction and Establishment of New Infestations
Healthy native plant communities help preclude the establishment of invasive plants and pinegrass is the dominant competitive vegetation throughout the project area and provides good competition in deterring the establishment of new weed introductions and the spread of existing weed populations (Williams and Lillybridge 1983)

Roads are the primary vector to carry seed for new weed introductions. There are currently 56 miles of open road with an additional 15.7 mile of unauthorized road within the project area. The introduction of invasive plants would occur primarily on these open roads. Approximately 63 miles of closed road in the project area is not susceptible to movement of invasive plants by vehicle traffic.

3.11.4 Environmental Consequences

3.11.4.1 Considered, but not Analyzed in Detail

The following proposed actions will not be considered further in this analysis because they would have no measurable effect on Invasive Plants: beaver habitat or coarse woody debris enhancement.

3.11.4.2 Alternative 1

3.11.4.2.1 Effects

The No Action alternative would maintain the 56.1 miles of open roads, of which 41 miles are infested with invasive plants, and 62.8 miles of close roads, of which 21 miles are infested with invasive plants. Refer to Figure 112 – Miles of Roads Infested with Invasive Plants by Alternative. As such, the No Action Alternative would have a higher potential for increasing the distribution (via vehicles) of invasive plants.

Invasive Plant introduction and spread by project vehicles and equipment would not occur. Ecological disturbance within the project area would increase due only to natural mechanisms (wind, water, wildlife, wildfire), on-going projects (cattle grazing), and public and administrative activity. With these mechanisms, introduction and spread rates would be dependent on natural conditions.

However, without this project, unnaturally high fuel levels would remain and the future condition would be expected to have a higher potential for severe wildfire. Fire is an important disturbance process in most ecosystems and usually favors early successional species. When

noxious weeds are present, many native early seral species have been replaced or are out-competed by nonnative invasive species which can alter successional pathways and subsequent fires (Harrod and Reichard 2001).

In a wildfire, the creation of fire lines (whether by hand or dozer), helispots, and heliports removes competing vegetation, exposes mineral soil, and increases light levels. If the fire is large, then fire suppression resources may come from across the nation or from outside the United States, and may bring new weed propagules (seed or plant parts) with them. Fire fighters, fire equipment, dozers, trucks, and helicopters can all transport weed propagules to fire lines, helispots, and burned areas. The establishment of fire camps also disturbs soil. Weeds already existing in these camps can act as source populations for the introduction of new weed species into the burned areas (USDA Forest Service 2004b). In the event of a high-severity wildfire and subsequent suppression actions, the disturbance level and vehicle/equipment traffic level, with minimal mitigation, may far exceed the effect of the action alternatives under this project, and there would be a short to long-term, moderate, adverse impact on the spread and new introduction and establishment of invasive plants.

No temporary road construction, decommissioning, or road closures would occur. The current level of vehicle access would continue with the introduction and spread of weeds by road users occurring relative to the level of traffic.

3.11.4.3 Alternative 2 and 3 – Proposed Action Effects Common to Both Action Alternatives or to Alternative 2 Only

Proposed thinning, prescribed fire, and soil treatments are identical in Alternatives 2 and 3 therefore the effects for both alternatives will be described together under Alternatives 2 and 3. The effects of the transportation changes will be analyzed under Alternative 3.

3.11.4.3.1 Effects

Figure 113. Invasive Plants Resource Indicators and Measures for Alternative 2 and 3 (non-transportation changes only)

Resource Element	Resource Indicator	Measure	Alternative 2
Invasive Plant Spread	Spread of existing infestations	Acres of Invasive Plants within Treatment Units	15.49 acres of New Invaders plus the Established Invader weeds
		Miles of road infested with Invasive Plants affected by Proposed Road Changes	62.36 miles

Invasive Plant Prevention	Introduction and Establishment of New Infestations	Acres of soil disturbance	61 acres – decommissioning (33.6 mi.) Up to 200 acres – commercial thinning
		Miles of road closures	34.8

Resource Indicator: Spread of Existing Infestations

Vehicles and transportation corridors are considered to be primary vectors for the movement of invasive plant species. Other vectors for spread include livestock, birds, insects, wildlife, wind and water. The introduction of nonnative plants can lead to substantial changes in the composition of the vegetation not only along road margins, but also, depending on dispersal abilities, may enable non-native plant species to spread into nearby habitats and beyond. The cascading ecological implication is further habitat loss (Bennett et al. 2011). As weeds are commonly associated with roads and old harvest activities, the potential effect of the Mission project on introduction and spread would be an increase of weeds on the road system and within areas of soil disturbance associated with the mission project activities. The risk of spread of New Invader weeds form existing populations is relatively low as there are only 19 acres within the project area.

Figure 114. Invasive Plant Infestations within Mission Project Area and Specific Restoration Treatment Activities

Invasive Plant	Acres	Treatment Unit Numbers	Treatment Activity	Number of Weed Sites
baby's breath	1.25	None		
St. Johnswort	2.33	359	TSI, HP, UB	5
		418	LFR, UB	
houndstongue	2.14	None		
common burdock	0.25	None		
oxeye daisy	5.42	057	LFR, DFR, MP	1
sulphur cinquefoil	3.63	047	LFR, DFR, MP	2
		407	LFR, UB	
whitetop	4.11	004	LFR, DFDMT, UB	3
New Invader Weeds Total	19.13			
diffuse knapweed	(*224)	Within all Units		
New Invader Acres within treatment units	15.49			
Total	243.13			

**The sum total of gross acres of mapped diffuse knapweed. There are additional acres that have not been mapped.*

Figure 115 displays miles of road currently infested with invasive plants, and, including diffuse knapweed, there would be 62 miles of the total 136 miles of road infested. Looking exclusively at New Invader weeds St. Johnswort and Sulfur cinquefoil make up the bulk of the miles, but

with less than ½ mile of the total 136 miles of roads infested. In addition to the 61.5 miles of mapped populations of diffuse knapweed, it is assumed that it can be found on all roads but with some relatively long stretches without any plants, some stretches that are widely scattered, as well as some very dense patches.

Figure 115. Alternative 2 and 3 Miles of Road Infested with Invasive Plants

Maintenance Level	Baby's breath	St. Johnswort	Diffuse knapweed	Oxeye daisy	Sulphur cinquefoil	White top	Total Miles
1 - BASIC CARE (CLOSED)			4.97	0.02			4.99
2 - HIGH CLEARANCE VEHICLES		0.16	18.32		0.08	0.01	18.57
3 - SUITABLE FOR CARS	0.07		21.33		0.10		21.49
4 - MODERATE USER COMFORT			2.73				2.73
D - DECOMMISSION		0.06	9.68	0.08			9.82
ML2 Admin			4.51	0.22		0.03	4.76
Total	*0.07*	*0.21*	*61.55*	*0.32*	*0.18*	*0.04*	*62.36*

Commercial Thinning, Noncommercial Thinning, including Ladder Fuels Reduction, Timber Stand Improvement, and Aspen Management Treatments: The forest restoration treatments would create a more open forest canopy. More light would provide more favorable conditions for noxious weeds; however, desirable plants that have been suppressed by a dense canopy would also benefit from a more open canopy. It is expected that there would be a relatively low level of expansion, except in areas where light levels and soil disturbance have increased. These areas would have the highest potential for expansion of existing weeds and would have the potential for establishment of new weed introductions from seed spread. The overall weed cover would remain relatively low.

There would be a total of 1952 acres of commercial harvest. Summer ground-based harvest would cause soil disturbance associated primarily with landings and skid trails. The level of ground based soil disturbance for this project is estimated to be up to 10% of the unit area which would be approximately 200 acres (see Soils, section 3.4). However, winter operations are required in some units to minimize soil impacts unless the purchaser can present a plan of no more than 2% detrimental soil conditions per unit. Substantially less than 200 acres of soil disturbance would occur with winter logging. Ground based winter harvest on frozen soils has shown to result in less detrimental soil disturbance as compared to summer harvest (Reeves et al. 2011). The potential for new weed establishment and spread is greatly reduced as there is virtually no soil disturbance that would create suitable germination sites and spread of existing weeds would be very low as the seeds would be under the snow.

There would be 187 landings. Landing sites pose a greater risk of establishment and spread of invasive plants because the soil disturbance is concentrated within these sites. Potential landing sites that are infested with invasive plants classified as New Invaders would be prioritized for pretreatment by the Invasive Plants Specialist. Landing sites that have not been pretreated will

be constructed away from areas infested with New Invader weeds. This mitigation will reduce the potential for spread.

Areas of heavily disturbed soils would be seeded, including landings and main skid trails. This would reduce soil erosion potential and area for weeds to become established. Seeding would establish competitive species to help prevent the spread of existing populations, and introduction and establishment of new noxious weed species. Certified weed-free seed would be used to help prevent new populations and species of weeds from entering the project area.

The combination of design features to minimize ground disturbance during summer operations and optional winter logging over snow would greatly reduce soil disturbance and better maintain the cover and density of desirable competitive vegetation to prevent spread or establishment of new weed populations. The spread of existing infestations and the introduction and establishment of new infestations by commercial thinning treatments would be a short to long-term, minor, adverse impact.

It is expected that there would be short term, negligible, adverse impacts to invasive plants as a result of the detrimental soil effects from proposed noncommercial thinning activities based on past monitoring of noncommercial thinning activities. Noncommercial and ladder fuel thinning operations are conducted by hand crews working across the landscape, which causes little detrimental soil disturbance.

Soil Treatments: Soil restoration treatments would occur where detrimental soil compaction exceeds ONFLRMP standards. The soil restoration treatments overlap with some dense diffuse knapweed populations, primarily in Chicamun and Ben canyons. The dense populations are all in forest openings, typically associated with roadsides, with few to no knapweed plants in the forest understory. The dense patches are very obvious and all populations would be pretreated where present within soil restoration treatments areas. The plants would be treated prior to seed production and would greatly limit the potential of spread. It is not anticipated that the seeds in the soil seedbank would attach to the subsoiler. The seeds would slide past along with the soil. A negligible amount of soil would attach to the subsoiler. New germination created by the soil disturbance would be post treated. A short-term, negligible, adverse impact is expected.

Prescribed Fire Treatments: It is not expected that underburning would increase the abundance of existing weeds with the exception of small high severity burned spots. A short-term, negligible, adverse impact is expected. Prescribed fire can stimulate native vegetation growth and colonization by increasing the availability of nutrients, space, light and water. These same attributes can also encourage establishment of invasive plants that may be better suited to occupy niches in fire areas that have burned too severely for natives to resprout or recolonize. Post-fire recovery of native species is determined by colonizers that seed into disturbed areas and survivors that resprout following fires (Brooks and Pike 2001). The responses of plant communities to fire depend on a host of factors, including the frequency and severity of fire, season and spatial extent of burns, preburn vegetation occurrence (including non-natives) and phenology, site conditions (particularly moisture, available nutrients, light, and disturbance history); and postfire conditions, including weather and availability of seed from invasive plants (Zouhar et al. 2008).

Proposed thinning treatments would create slash piles which would be removed through burning. Both hand piling and machine piling would be used. Machine piles would be between 4' x 4' up to 8' x 8'. Machine piling the slash would result in soil disturbance however the largest piles are typically placed in the pre-existing disturbed soil areas within landings minimizing the level of additional disturbance. Large slash pile burning concentrates the heat of the fire in a single location, causing greater disturbance to the soil and plants in the area of the pile. Pile locations would be seeded post-burning. A study of slash pile burning in ponderosa pine forests found that burning of larger slash piles nearly eliminated populations of viable seeds and generated scars with increased susceptibility to invasion of exotic plant species (Korb et al. 2004). Native seed was used in the study which found that at a minimum, the slash pile areas need to have seed amendments and that amending the slash pile scars with native seeds increased the cover of native forbs and grasses and reduced the cover of exotic weed species relative to untreated scars. In addition to seeding, potential landing sites that are infested with New Invader weeds would be a high priority for pretreatment under the 2000 Noxious Weed Environmental Assessment. Landings that have not been pretreated would be constructed away from areas infested with New Invader weeds. Machine piling equipment would be cleaned prior to entering the project site. A short-term, moderate, adverse impact to invasive plants is expected where some of the established invader weeds like common mullein and bull thistle would increase in the burned areas of the larger slash piles but give way to natives after about 5 years.

Construction of the proposed 29.4 miles of hand fireline and 2.6 miles of machine fireline would increase the risk of weed spread and introduction. A short-term, negligible, adverse impacts is expected. To reduce the risk of spread, no dozer or hand line construction would occur within existing weed patches and existing roads and natural barriers will be utilized as firelines wherever possible to minimize soil disturbance. Hand lines would not be seeded as the line is usually not wide enough (up to 18 inches) to limit relatively rapid revegetation from existing native propagules. The dozer lines (3-5 feet wide) would predominately scrape off the above ground biomass with much of the perennial roots remaining in the soil for regeneration. The Fuels specialist and Botanist will determine whether spot seeding is necessary to restore the line to its pre-disturbance natural vegetation. New Invader populations near proposed containment lines will be identified on Burn Plan maps so that the populations can be avoided.

Rock armoring, replacing undersized culverts or installing fish culverts, creating hardened fords: The risk of introduction of new infestations or spread of existing infestations would be low as no ground disturbing equipment would be operated outside the limits of the road prism. If there is a need to work outside of the road prism for the culvert work, rock armoring, and hardened fords; these actions would require the cleaning of all heavy equipment prior to entering National Forest System Lands reducing the risk of new introduction and spread. A short-term, negligible, adverse impact is expected.

Resource Indicator: Introduction and Establishment of New Infestations
Road Closures: Alternative 2 would close 34.8 miles of road. Invasive plant treatment access and spread by vehicle traffic are affected by changes in road maintenance levels. Closing open roads to ML1 or ML2 Administrative Use status would reduce the potential for weed spread by

vehicles. However, access for weed treatments would be more limited with a slight reduction in treatment efficacy. It is expected that a long-term, beneficial, minor impact would be expected by road closures for both alternatives. The reduced risk of spread by vehicles outweighs the more limited access for treatment.

Road Decommissioning: Alternatives 2 would disturb 33.6 of road by decommissioning (estimated 61 total acres of disturbance). Diffuse Knapweed as well as other established invader weeds are present to some extent on all roads to be decommissioned. Other than the established invaders, the only new invader weeds are Oxeye daisy and St. Johnswort. Decommissioning may include blocking the entrance to a road or installing water bars; removing culverts, reestablishing drainages, removing unstable fills, pulling back road shoulders, and/or scattering slash on the roadbed; or completely eliminating the roadbed by restoring natural contours and slopes.

Decommissioning increases the risk of spread of existing populations and new introductions of weeds. Where weeds are established on the roadbeds, decommissioning activities may disturb dormant noxious weed seedbeds and increase weed densities. In a review of the benefits and impacts of road removal, Switalski et al. (2004) reported that decompacting the road surface loosens soil and increases infiltration capacity, improving the germination and growth of seeded plants. Switalski et al. (2004) looked specifically at road ripping and reported that while road ripping has been shown to increase the rate of revegetation, it may also create conditions conducive to weed invasion. Monitoring and preliminary research, however, suggest that ripping may actually reduce the risk of invasions, because native vegetation is able to out-compete weeds and because ripping eliminates vehicles as a primary vector for further invasions.

A study was conducted on the Kootenai National Forest regarding the effects of road decommissioning on intact vegetation and the effects of seeding after decommissioning. They had expected that the short-term disturbance associated with decommissioning would result in high rates of weed invasion. In contrast, non-native plants were present at less than 1% cover one year after decommissioning. Given the low levels of non-natives immediately after road decommissioning, this time period may be crucial for establishing native vegetation before non-natives have the opportunity to colonize (Grant et al. 2011). Design Criteria that would be required by the action alternatives would seed all road disturbance activities and would be effective in native plant establishment. Seeding in the same operational season that the roads are decommissioned would be most effective to meet erosion control and invasive plant competition objectives establishing desirable vegetation before non-natives have the opportunity to colonize.

Off-road equipment would be brought in from areas outside the Forest that may have noxious weed infestations. The equipment may have mud or soil with noxious weed seed or plant parts attached. All off-road equipment would be cleaned prior to entering National Forest. Equipment cleaning would be effective in reducing the risk of invasive species introduction from this equipment.

With the implementation of the design criteria, the impacts of Alternative 2 would be reduced. A minor, short to long-term, adverse impact is expected for road decommissioning under Alternative 2.

3.11.4.4 Alternative 3 - Effects Unique to Alternative 3

3.11.4.4.1 Effects

Alternative 3 has the same effects as Alternative 2 except for resource indicators related to transportation changes (see **Figure 116**).

Figure 116. Invasive Plants Resource Indicators and Measures for Alternative 3 (transportation changes only).

Resource Element	Resource Indicator	Measure	Alternative 3
Invasive Plant Prevention	Introduction and Establishment of New Infestations	Acres of soil disturbance	102 acres – decommissioning (56.2 mi.)
		Miles of road closures	33.8 miles

Resource Indicator: Introduction and Establishment of New Infestations

Road Closures: Alternative 3 would close 33.8 miles of road. Invasive plant treatment access and spread by vehicle traffic are affected by changes in road maintenance levels. Closing open roads to ML1 or ML2 Administrative Use status would reduce the potential for weed spread by vehicles. However, access for weed treatments would be more limited with a slight reduction in treatment efficacy. It is expected that a long-term, beneficial, minor impact would be expected by road closures for both alternatives. The reduced risk of spread by vehicles outweighs the more limited access for treatment. For road closures, Alternative 3 would have the greatest benefit in reducing new introductions and spread of exiting infestations.

Road Decommissioning: Alternative 3 would disturb 56.2 miles of road by decommissioning (estimated 102 acres of total disturbance). Diffuse Knapweed as well as other established invader weeds are present to some extent on all roads to be decommissioned. Other than the established invaders, the only new invader weeds are Oxeye daisy and St. Johnswort. Decommissioning may include blocking the entrance to a road or installing water bars; removing culverts, reestablishing drainages, removing unstable fills, pulling back road shoulders, and/or scattering slash on the roadbed; or completely eliminating the roadbed by restoring natural contours and slopes.

With the implementation of the design criteria, the impacts of both alternatives would be reduced. A moderate, short to long-term, adverse impact for Alternative 3. Alternative 3 would have the highest risk of introduction of new invasive plants and spread of existing infestations than Alternative 2 and a much higher risk than the no action alternative.

3.11.4.4.2 Cumulative Effects

Spatial and Temporal Context for Effects Analysis

This cumulative effects analysis considers effects of past, present and reasonably foreseeable future actions along with the effects of the Mission Restoration Project. The geographic boundary for this cumulative effects analysis is the entire Mission Analysis Area plus adjacent private land. The temporal boundary is the period of time from the past 50 years, since the bulk

of the road system was developed, to 10 years in the future, the time in which the alternatives have the potential to affect invasive plant spread and establishment.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis
Past Actions: In order to understand the contribution of past actions to the cumulative effects of the proposed action, this analysis relies on current environmental conditions as a proxy for the impacts of past action. This is because existing conditions reflect the aggregate impact of all prior human actions on natural events that have affected the environment and might contribute to cumulative effects.

Present and Future Actions: Integrated weed management (IWM) within the Mission Analysis Area under existing Forest-wide decisions (USDA-FS 2000) would continue to reduce or eliminate New Invader weed infestations on roads. The combination of herbicide, manual, and cultural treatment would provide effective control of small populations. Treatments would be conducted by the DISTRICT Weed program with herbicide treatments authorized under the 2000 Okanogan National Forest Integrated Weed Management EA Decision Notices. The 2005 Invasive Plant Management prevention standards that apply to all applicable forest projects and would reduce the rate of spread from 8-12% to about 5% (USDA-FS 2005a). Although the rate of spread is slowed, spread is not entirely stopped.

The New Invader weed sites within the Mission Analysis Area would be prioritized and treated with herbicide as authorized by the existing IWM decisions. Not all weed sites would be treated. Priority sites that would be treated include weed populations on roads proposed for decommissioning and roads proposed for closure. Consequently, weed densities are currently being reduced or would be reduced along some roads before project implementation.

The Okanogan-Wenatchee NF Forest-wide Site-Specific Invasive Plant Treatment EIS will be completed by 2017, which would authorize the treatment of currently existing invasive species across the Okanogan-Wenatchee NF and would allow for treatment of infestations that are not currently inventoried through an Early Detection/Rapid Response (EDRR) strategy. The proposed invasive species treatments may begin within two years and continue for 15 years. Invasive plants would be treated using one or a combination of manual, mechanical, cultural, biological, and chemical methods. Priorities for treatment and selection of treatment methods would be consistent with those described in the R6 2005 FEIS (USDA-FS 2005a).

Potential Invaders on non-Forest lands listed in the existing condition section of this document could spread from outside the Mission Analysis Area along open roads from vehicular traffic to newly-disturbed closed or decommissioned roads. Some ongoing treatments are occurring on this populations, which are outside of the DISTRICT's influence.

Active fire suppression would continue in the Mission Analysis Area. Those fire suppression activities that include the use of the roads could transport New Invader seeds into and around the Mission Analysis Area. However, vehicle weed wash stations are often available and implemented and restoration work is completed on area of suppression disturbance.

All types of recreation would continue to be a source of weed introduction and spread within the Mission Analysis Area.

Cattle would continue to function as weed vectors for spread and introduction. It is likely that some of the New Invader populations were introduced by cattle within the Mission Analysis Area. Despite the relatively large number of cattle that are brought in from areas outside the Mission Analysis Area, extensive weed surveys in recent years have not detected any of the weed species listed as Potential Invaders and most invasive populations are along roads, not in the general forest where cattle graze.

The Motorized Travel Management Project would designate roads, trails and areas open for motorized vehicle use and close the remainder of the Forest to motorized use.

Road maintenance activities would continue to have the potential to spread weeds. Activities would include improvement of drainage structures, road surface shaping and grading, and ditch cleaning. In accordance with 2005 PNW ROD Standard #8, road blading and ditch cleaning in areas with high concentrations of invasive plants would be done in consultation with the District invasive plant specialists and would incorporate invasive plant prevention practices described in the Prevention and Management Strategy (USDA-FS 2004) as a way to minimize the spread of weeds.

Resource Indicator: Spread of existing infestations and Introduction and Establishment of New Infestations

The cumulative effect of past, present, and reasonably foreseeable future actions and the proposed thinning treatments and transportation changes in Alternatives 2 and 3 would have short term, adverse, negligible to minor impacts on invasive plants. Ongoing integrated weed management work would add to the design criteria to reduce the spread and new introductions of invasive plants within the project area. Implementation of the Invasive Species Treatment EIS would increase the number of weed treatment options available and increase the area of infested lands that may be treated within the Project area. Using the EDRR strategy on newly discovered infestations would increase treatment effectiveness and reduce the potential for spread and establishment and of new populations. Active fire suppression would reduce the potential for large scale wildfire where the impacts of the suppression actions may far exceed the effect of the action alternatives under this project. The action alternatives would create more transitory range, potentially changing cattle distribution in the analysis area and increase access to invasive plant populations, however the large project area would lend to equal dispersal of cattle away from the existing populations. The Motorized Travel Management Project would reduce the miles of road accessible by motorized vehicles reducing the risk of introduction and spread of invasive plants. The Ongoing road maintenance activities would continue to have the potential to spread and introduce new infestations but combined with the ongoing weed treatments and the implementation of the Invasive Species Treatment EIS, the expected impacts would be short term and negligible.

Under Alternative 1 Invasive Plant introduction and spread by project vehicles and equipment would not occur, however densely stocked stands with multiple canopy layers would not be thinned resulting in unnaturally high fuel levels with a higher potential for severe wildfire. In the event of a wildfire, fire suppression activities and the disturbed burned area would have a greater potential for introduction of new invasive plants as well as spread of existing

populations. The current level of vehicle access would continue with the introduction and spread of weeds by road users occurring relative to the level of traffic.

Alternatives 2 and 3 would result in more soil disturbance than no action and a higher risk of spread of noxious weed seed. Both alternatives would also increase the risk of introduction of new noxious weeds into the project area by vehicles and equipment and would create more soil disturbance than alternative 1. However, implementation of the design features in conjunction with the Prevention and Management Strategy would reduce the risk of introduction and spread of noxious weeds. In addition, the action alternatives would reduce fuel levels more than no action, thereby reducing the risk of uncharacteristic high severity fire and the soil disturbance associated with fire effects and fire control.

Some of the proposed forest vegetation treatment units contain populations of invasive plants, but most of the populations are directly associated with roads and historical harvest activities. Few populations occur in undisturbed off-road areas. The spread of existing populations would be greatest in areas where harvest activities intersect roads and other historical disturbance (i.e., past timber harvest and grazing). The total acres of potential weed spread for all project activities is very small area relative to the total acres of forest restoration treatments.

Both action alternatives would reduce potential for spread in the long-term on closed and decommissioned roads by preventing vehicular access. The expected outcome would be a short-term increase in the abundance of Established Invaders and slight increases in the abundance of New Invaders. Alternative 3 would have more miles of decommissioning increasing the potential for new introduction and spread of weeds. In the long-term, with implementation of prevention strategies, mitigation measures, and on-going weed management, the rate of spread of weed populations would be reduced, and weed populations along closed and decommissioned roads in this project area would be reduced.

3.11.4.5 Summary of Effects

Under Alternative 1 Invasive Plant introduction and spread by project vehicles and equipment would not occur, however densely stocked stands with multiple canopy layers would not be thinned resulting in unnaturally high fuel levels with a higher potential for severe wildfire. In the event of a wildfire, fire suppression activities and the disturbed burned area would have a greater potential for introduction of new invasive plants as well as spread of existing populations. The current level of vehicle access would continue with the introduction and spread of weeds by road users occurring relative to the level of traffic.

Alternatives 2 and 3 would result in more soil disturbance than no action and a higher risk of spread of noxious weed seed. Both alternatives would also increase the risk of introduction of new noxious weeds into the project area by vehicles and equipment and would create more soil disturbance than Alternative 1. However, implementation of the design features in conjunction with the Prevention and Management Strategy would reduce the risk of introduction and spread of noxious weeds. In addition, the action alternatives would reduce fuel levels more than no action, thereby reducing the risk of uncharacteristic high severity fire and the soil disturbance associated with fire effects and fire control.

Figure 117. Summary of Invasive Species Resource Indicators and Measure for All Alternatives

Resource Element	Resource Indicator	Measure	Existing Conditions (Alternative 1)	Alternative 2	Alternative 3
Invasive Plant Spread	Spread of existing infestations	Acres of Invasive Plants within Treatment Units	243.13 acres of Established Invader weeds; **0 acres** of New Invader weeds	**15.49 acres** of New Invaders plus the Established Invader weeds	**15.49 acres** of New Invaders plus the Established Invader weeds
		Miles of road infested with Invasive Plants affected by Proposed Road Changes	62.38 miles	62.36 miles	62.36 miles
Invasive Plant Prevention	Introduction and Establishment of New Infestations	Acres of soil disturbance	0 acres	61 acres – decommissioning (33.6 mi.) Up to 200 acres – commercial thinning	102 acres – decommissioning (56.2 mi.) Up to 200 acres – commercial thinning
		Miles of road closures	0 miles	34.8 miles	33.8 miles

Some of the proposed forest vegetation treatment units contain populations of invasive plants, but most of the populations are directly associated with roads and historical harvest activities. Few populations occur in undisturbed off-road areas. The spread of existing populations would be greatest in areas where harvest activities intersect roads and other historical disturbance (i.e., past timber harvest and grazing). The total acres of potential weed spread for all project activities is very small area relative to the total acres of forest restoration treatments.

Both action alternatives would reduce potential for spread in the long-term on closed and decommissioned roads by preventing vehicular access. The expected outcome would be a short-term increase in the abundance of Established Invaders and slight increases in the abundance of New Invaders. Alternative 3 would have more miles of decommissioning increasing the potential for new introduction and spread of weeds. In the long-term, with implementation of prevention strategies, mitigation measures, and on-going weed management, the rate of spread of weed populations would be reduced, and weed populations along closed and decommissioned roads in this project area would be reduced.

3.11.5 Consistency Statement

Both Alternatives 2 and 3 are compliant with Executive Order 13112, the Forest Plan (USDA 1989) and the Northwest Forest Plan (USDA & USDI 1994) standards because they "… include required prevention strategy standards which would minimize the creation of conditions that favor invasive plant introduction, establishment and spread. Off-road equipment would be cleaned prior to entering the forest, and only weed free straw, mulch, gravel, fill, sand, or rock

would be used. Native seed would be the first choice in re-vegetation in areas where the objective is to restore the site to the landscape setting, such as decommissioned roads. Non-native seed may be used to help prevent the establishment of invasive species, in permanently altered plant communities, and in situations where locally collected native seed is not available.

FSM 2080.2 is also followed because an Integrated Weed Management Approach is used through implementation of the existing Okanogan National Forest IWM decisions. Relevant parts of the Okanogan and Wenatchee National Forests Weed Management and Prevention Strategy and Best Management Practices (USDA 2001a), the Guide to Noxious Weed Prevention Practices (USDA 2001b) supporting the February 3, 1999 Executive Order on Invasive Species, and the National Strategy and Implementation Plan for Invasive Species Management (USDA 2004) are also included in design criteria.

Forest Plan Amendment Effects on Substantive Provisions

To meet Purpose and Needs #2, #3, #4 and #6 identified in Chapter 1 of the EA, vegetation management through thinning would reduce deer winter range cover below Okanogan National Forest Land Resource Management Plan Standard and Guidelines MA14-6A and MA26-6A, requiring a project-specific amendment. The 2012 Planning Rule as amended (36 CFR 219) requires consideration of how such an amendment would affect substantive provisions identified in the Planning Rule. With respect to invasive plants, the following substantive provisions would be affected by the proposed amendment:

219.8(a)(1)(iv) System drivers including stressors such as invasive species. Thinning in up to 746 acres would occur under the amendment would create a more open forest canopy, allowing more light to reach the surface and creating an adverse, short-term, negligible impact on the potential spread of invasive plants. However, desirable plants that have been suppressed by a dense canopy would also benefit from a more open canopy. Thinning would decrease the risk of crown fire and the potential disturbance caused by the subsequent suppression actions, which in turn reduces the risk of new introduction and spread of invasive plants. Project design criteria would minimize soil impacts that promote invasive species introduction and would maintain the cover and density of desirable competitive vegetation.

Because approximately half of the proposed thinning would occur in deer thermal cover, then up to half of the thinning area proposed under this amendment in Alternatives 2 and 3 would create a more open forest canopy. More light would provide more favorable conditions for invasive plants;

3.12 Recreation and Scenic Resources

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Recreation and Scenic Resources Report by E. Peterson (2016), available in the project record. Reference information is contained in the full specialist report.

3.12.1 Methodology

The following resource indicators and measures will be used to analyze effects to recreation and scenic resources from the proposed actions:

Figure 118. Recreation and Scenic Resource Indicator and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Scenic Quality	Visual Quality Objective (VQO) Scenic Integrity Level	Very High, High, Moderate, Low, or Very Low	No	LRMP
Recreational Access	Recreational access to and use of Scaffold Ridge/Oval Peak Trail	Type of access to trailhead; trail maintained or unmaintained.	Yes; P&N #7	Okanogan National Forest Travel Plan

Resource Indicator: Visual Quality Objective Scenic Integrity Level

The scenic quality will be assessed by determining the Scenic Integrity Level (high, moderate, or low) and Visual Quality Objective (retention, partial retention, modification) of each treatment area based on the length of viewing time, and deviations in the landscape character elements of form, line, color, texture, and pattern.

The project area is seen as foreground (views up to ½ mile distance) and middle ground (views up to 4 miles distance) from several viewsheds and viewpoints. For scenic analysis on this project, they will be grouped into the following area:

Buttermilk Creek Viewshed: Forest Roads 43, 4340 and 4300-100, 4300-200, 4300-300, 4300-400, and 4300-500, Black Pine Lake Campground, Black Pine Meadow, Mission Pond, and private residences along the valley bottoms. Scenic integrity is the amount of human caused deviation in form, line, color, and texture of a landscape.

Scenic integrity serves as a frame of reference for measuring scenic integrity levels based on the valued attributes of the existing landscape character being viewed. The degrees of integrity vary from VERY HIGH to VERY LOW. The following table displays the 5 scenic integrity levels and conditions associated with each level.

Figure 119. Scenic Integrity levels and conditions

Scenic Integrity Level	Condition
VERY HIGH (Preservation VQO)	Unaltered
HIGH (Retention VQO)	Appears Unaltered
MODERATE (Partial Retention VQO)	Slightly Altered
LOW (Modification VQO)	Moderately Altered

VERY LOW (Maximum Modification)	Heavily Altered

Resource Indicator: Recreational Access to Scaffold Ridge/Oval Peak Trail
Access to this area will be analyzed based on proposed changes to the transportation system that would open or decommission these roads and allow for or remove access for trail maintenance on the Scaffold Ridge trail.

3.12.2 Intensity Level Definitions

Type of Impact:

- Beneficial: Enhance visitor participation, visual quality, quality of visitor experience and/or service level.
- Adverse: Reduce visitor participation, degrades visual quality, quality of visitor experience, and/or service level.

Duration of Impact:

- Short-term: Temporary in nature, occurring primarily during the period when a fire or vegetation management activity would take place.
- Long-term: Permanent effect on the visitor experience or that effects are detectable for more than five years after proposed actions.

Intensity of Impact:

- None: No effect
- Negligible: Imperceptible or undetectable effect upon visitors.
- Minor: Slightly detectable or localized effect on visitors. Limited to a relatively small area.
- Moderate: Readily apparent effects on visitors.
- Major: Substantial, highly noticeable effects and/or effects that would result in major limits on activities and/or results in a change of character of the landscape.

3.12.3 Affected Environment

The proposed action encompasses a popular recreational area on the Methow Valley Ranger District that surrounds the Buttermilk Creek drainage, up to Buttermilk Butte, the Mission Creek drainage, as well as the area south of the Twisp River. Black Pine Lake Campground is the only developed campground facility in the project area and receives at least 4,000 visitors a season, where visitors camp, fish, and swim in the lake, and hike and bike in the surrounding hillsides. The area is popular with snowmobilers in the winter season as Forest Service Roads #43, #4340, #4300-300, #4300-400 are groomed snowmobile routes. Numerous other non-groomed snowmobile routes are also in the area. The West Fork Buttermilk, East Fork Buttermilk, Scaffold Ridge, and Libby Lake Trailheads are within the project boundary. About 10% of the Lake Chelan – Sawtooth Wilderness and about 3% of the Sawtooth Inventoried Roadless Area are also inside the project boundary. The project area contains 5534 acres of unroaded area, defined in this analysis as including NFS lands outside of wilderness that are more than one-half mile from an existing road. Figure 120 below shows the location of wilderness, IRA, and unroaded area in the project boundary with proposed treatments. The Mission Restoration Project area has a range of scenic integrity levels (conditions) from LOW to HIGH, *moderately altered* to *appears unaltered* based on vegetative characteristics.

Resource Indicator: Visual Quality Objective (VQO) Scenic Integrity Level
Existing scenic integrity levels meet the Forest Plan Standards and Guidelines for a natural appearing foreground viewed from the designated travel routes. Some areas allocated to MA-25, which has a VQO of Modification, also meet a higher scenic integrity level of Partial Retention to Retention (see Figure 121).

Note to reader: Page references provided in the Notice of Opportunity to Comment for the Mission Revised Preliminary EA may be off by one number in this excerpt from the full document.

Figure 120. Inventoried roadless and unroaded areas in project area, with proposed treatments displayed.

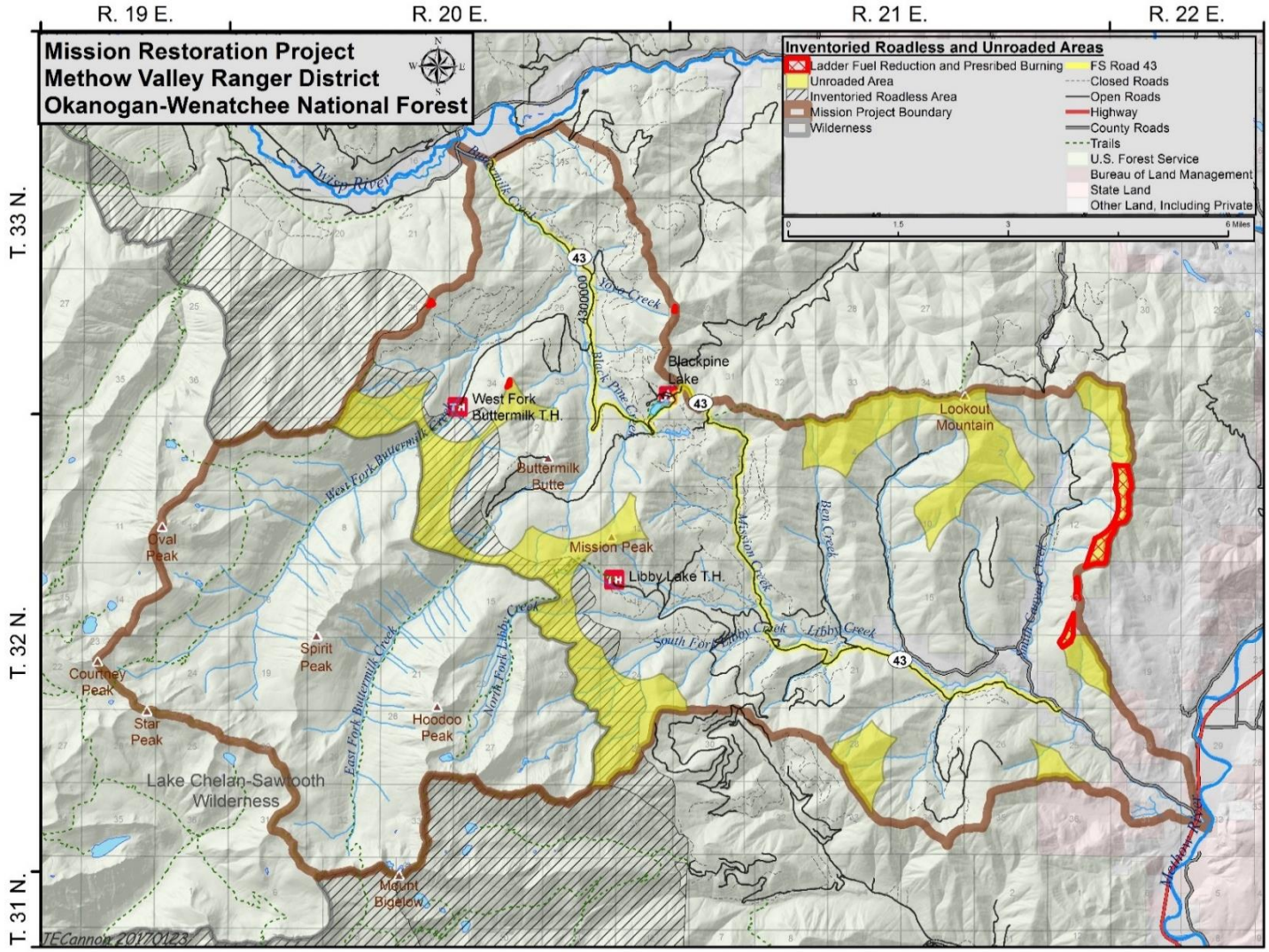
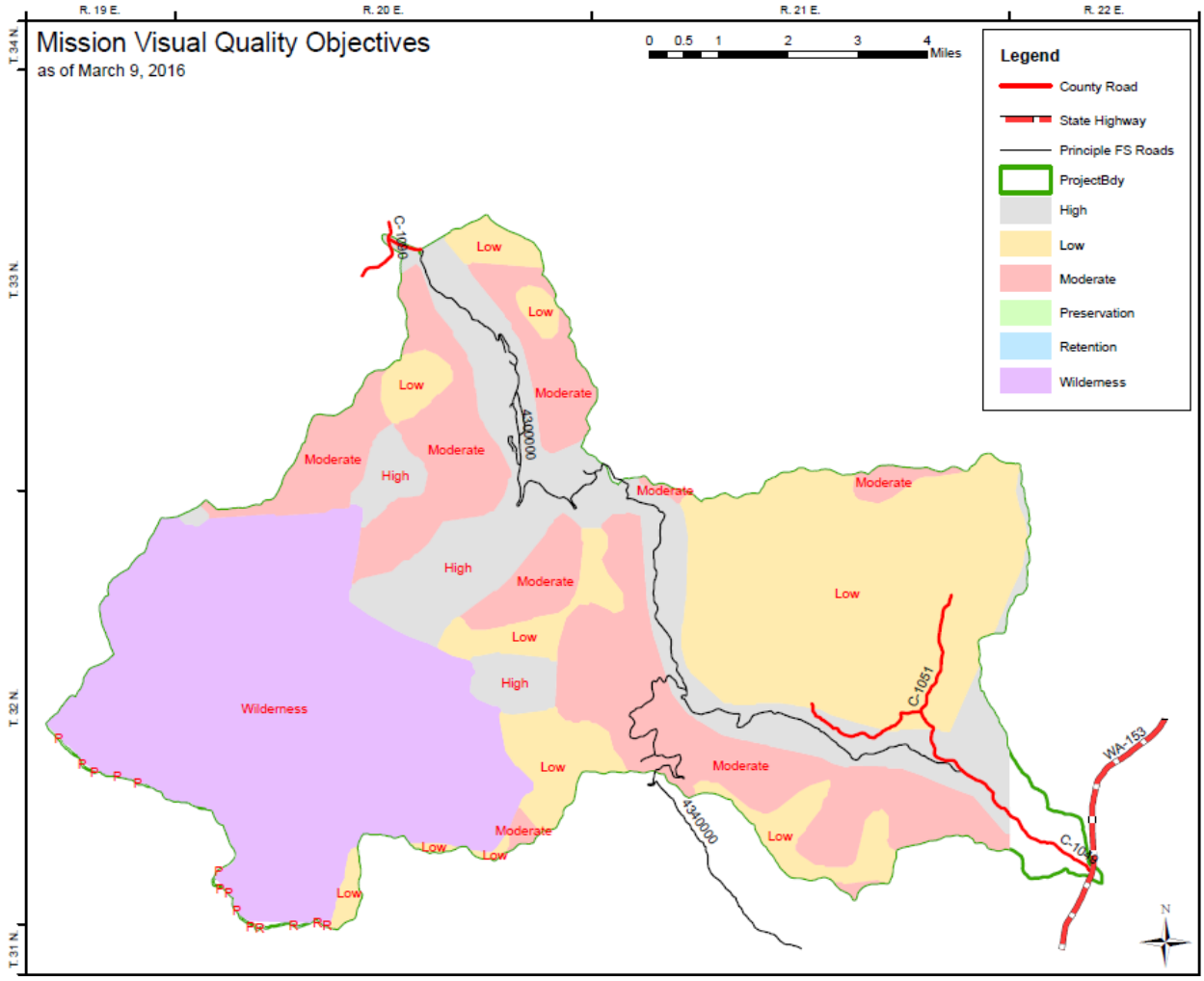


Figure 121. Visual Quality Objective (VQO) Scenic Integrity Level



The project area is seen as several dissected valley landforms while traveling up the #4300 road. Landmarks within the project area include Black Pine Lake and Black Pine Meadow, Mission Pond, Buttermilk Butte, and the Lake Chelan-Sawtooth Wilderness peaks. There are a variety of viewing opportunities within the project area ranging from enclosed views of the road lined valley bottom to more open vista views of the surrounding landscape seen from higher vantage points of Forest Roads 43 and the 4300-400.

The landscape setting of the Buttermilk Creek and Mission Viewsheds are a highly to coarsely textured foreground and middleground view from Forest Road 4300. The existing condition is natural appearing along the travel route incorporating variety with open grassy hillsides to the east. The open hillsides add form to the tree lined valley corridor with a distinct change in vegetative species. The landscape character is rural in nature along the valley bottom.

The existing MODERATE to HIGH scenic integrity levels areas with high fuel loadings have a high potential to result in a sudden change to the landscape character if a high-severity wildfire occurred that created a burned off area. The landscape character would dramatically change from a green forested setting to an area dominated by the visual evidence of wildfire. Fire intensity patterns would probably range from low to moderate to high viewed in foreground and middleground from the Buttermilk road #4300, developed campground, and important travel routes off the 4300 road. The visual effects of a large scale wildfire would change the landscape character to a black, brown, and green interwoven landscape pattern. Wildfire visual characteristics would be visually dominant and evident for 5 to 10 years; snags would be created as a result of the wildfire. The snags would be dominant for at least 5 years, and then begin to fall and create a jackstraw effect along some trail and road corridors which would appear visually negative.

Resource Indicator: Recreational Access to Scaffold Ridge/Oval Peak Trail
Currently the bridge accessing the roads and trail to Scaffold Ridge is closed to motorized travel because of safety concerns. In order to show consistency with current travel conditions, the roads accessing the Scaffold Ridge trail were designated "closed" to motorized travel because the bridge was closed. No management decision was made to close these roads for resource concerns in past environmental analyses. Non-motorized recreationists (such as mountain bikers, hikers, and horseback riders) are able to use the bridge and roads to access the trail. Trail maintenance has not occurred on the Scaffold Ridge trail since the bridge was closed due to lack of motorized access.

Figure 122. Scenic Resource Indicator and Measures for the Existing Condition

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
Scenic Quality	Visual Quality Objective (VQO) Scenic Integrity Level	Very High, High, Moderate, Low, or Very Low	MODERATE to HIGH
Recreational Access	Recreational access to and use of Scaffold Ridge/Oval Peak Trail	Access is open or closed. Trail maintenance occurs or does not occur.	Non-motorized access only. Motorized access closed because of bridge damage; trail maintenance is not occurring due to lack of motorized access.

3.12.4 Environmental Consequences

3.12.4.1 Considered, but not Analyzed in Detail

3.12.4.2 Alternative 1

3.12.4.2.1 Effects

Resource Indicator: Visual Quality Objective (VQO) Scenic Integrity Level
The effect on scenic quality with no action would be long-term, adverse, and moderate. By not managing the landscape overall and reducing the dense vegetation patterns through thinning and prescribed burning, the visual quality may not be maintained. Trees may succumb to drought, insect or diseases if they are stressed and over compete for water, sunlight, and other growing conditions. Large tree growth in the landscape, a dry series type, may be reduced. The landscape may become more unstable, and non-sustainable as a forest in this typically Northeast Cascade vegetative character type. This would detract from the high scenic quality setting in the viewsheds. By not treating the landscape either through thinning, commercial harvest, or prescribed fire, any benefits to visual quality would not be realized.

Resource Indicator: Recreational Access to Scaffold Ridge/Oval Peak Trail
Currently the bridge across West Fork Buttermilk Creek that provides access to the roads and trail to Scaffold Ridge is closed to motorized traffic due to safety concerns. Alternative 1 would keep the roads in place but they would remain closed to motorized access.

3.12.4.3 Alternatives 2 and 3– Proposed Action Effects Common to Both Action Alternatives or to Alternative 2 Only

Both the Recreation Resource and the Scenic Resource would not be affected by coarse woody debris enhancement, soil restoration, rock armoring, hardened fords, or beaver habitat enhancement because these activities would not inhibit recreational access, enjoyment of the area, or visual quality. Culvert replacement would only be a short term closure of roads for recreational access, but would not affect the access long term. The scenic resource would not be affected by culvert replacement. For these reasons, the effects from Alternatives 2 and 3 will be the same for Scenic Integrity and snowmobile access and are analyzed as such.

Alternative 3 includes additional road decommissioning and road closing which will have an effect on recreational access indicators and will be analyzed separately.

3.12.4.3.1 Effects

Figure 123. Recreational and Scenic Resource Indicators and Measures for Alternatives 2 and 3

Resource Element	Resource Indicator	Measure	Alternatives 2 and 3
Scenic Quality	Visual Quality Objectives Scenic Integrity Level	Very High, High, Moderate, Low, or Very Low	49 Units and 16 partial units in High 50 units and 29 partial units in Moderate 28 units and 10 partial units in Low
Alternative 2 Only			
Recreational Access	Recreational access to and use of Scaffold Ridge/Oval Peak Trail	Access is open or closed. Trail maintenance occurs or does not occur.	Open for motorized and non-motorized recreational access pending bridge repair. Trail maintained after motorized access is restored.

Resource Indicator: Visual Quality Objectives Scenic Integrity Level
The proposed actions of Alternatives 2 and 3 would have long-term, beneficial, moderate effects and would meet the established visual quality objective of Partial Retention along the foreground of the Buttermilk Creek viewshed. Landscape character changes would be seen as a range of thinned stands of trees to a more open forested canopy character. Managing dense vegetation and prescribed burning in some riparian areas would enhance scenic quality in the long term by revitalizing riparian vegetation.

Overall, the rest of the project area would meet a range of Visual Quality Objectives from Retention to Partial Retention to Modification. Post project scenic integrity levels would be higher than Forest Plan standards in some places which would benefit scenic resources.

Areas where ground based logging would occur would show evidence of skid trails, temporary road construction, and landings. Scenic quality would need to be maintained around campgrounds, trails and other routes used for year round recreation. The immediate foreground (up to 300') is the sensitive zone, shade retention objectives would be important for maintaining the trails winter use. The following routes have a higher sensitivity being managed as recreation routes for authorized routes: Use irregular clumping and feathering of unit edges to avoid introducing dominating lines that could result from creating small patch openings.

Resource Indicator: Recreational Access to Scaffold Ridge/Oval Peak Trail (Alternative 2 only)
Alternative 2 would allow for recreational access to Scaffold Ridge/Oval Peak Trail by keeping the roads in place and opening motorized access after the bridge is repaired when funding is available. Until the bridge is repaired, nonmotorized access would continue as described for Alternative 1. Trail maintenance would resume once motorized access was re-established. The effects of this alternative on recreational access would be long-term, beneficial, and moderate.

3.12.4.4 Alternative 3

3.12.4.4.1 Effects

Figure 124. Recreational and Scenic Resource Indicators and Measures for Alternative 3

Resource Element	Resource Indicator	Measure	Alternatives 3
Recreational Access	Recreational access to and use of Scaffold Ridge/Oval Peak Trail	Access is open or closed. Trail maintenance occurs or does not occur.	Unmaintained route open for stock access. No further trail maintenance would occur.

Resource Indicator: Recreational Access to Scaffold Ridge/Oval Peak Trail
This alternative would decommission the primary access road to the trail in such a way as to provide non-motorized access for stock for the purpose of use and administration of the grazing allotment. Non-motorized recreational users would be able to use the route, but the route would not be maintained as a system trail and would likely become impassable over time without regular maintenance. The current bridge would remain in place, allowing non-motorized use to cross over the West Fork Buttermilk Creek. The Scaffold Ridge trail would no longer be

maintained due to lack of motorized access. This alternative would have long-term, adverse, and major effects on recreational access to Scaffold Ridge/Oval Peak Trail.

3.12.4.4.2 Cumulative Effects
Spatial and Temporal Context for Effects Analysis: The spatial boundary for analyzing the cumulative effects to the scenic integrity levels and recreation users in the viewsheds is the project area boundary.

The temporal boundary is from the time of implementation of this project to 10 years into the future, the time span when effects from this project have either ceased or become similar to the background.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis: In addition to those past, present and reasonably foreseeable future actions listed in Chapter 3, vegetation management and hazard tree reduction in the Black Pine Lake Campground will be ongoing activities that coincide with the Mission Restoration project. As no project activities are proposed within the Black Pine Lake Campground, there are no cumulative effects anticipated for this recreational project. There would be no long-term effect on snowmobiling opportunities in the analysis area with implementation of the Proposed Action. All existing groomed snowmobile routes would continue to be groomed in the future.

Resource Indicator: Visual Quality Objectives Scenic Integrity Level
Hazard tree reduction and vegetation management in the Black Pine Lake Campground is ongoing.

Other past, ongoing and reasonably foreseeable future actions listed at the beginning of Chapter 3 of the EA do not cumulative interact with visual impacts from the Mission Restoration project.

Resource Indicator: Recreational Access to Scaffold Ridge/Oval Peak Trail
Alternative 2 would allow for motorized vehicle access to the Scaffold Ridge/Oval Peak Trail after bridge repair is completed, which may increase visitor use and recreational access to the area. More recreational visitors will more than likely be drawn to the trail, but not in any substantial numbers. Trail maintenance would resume once motorized access is re-established by repairing the bridge.

3.12.4.5 Summary of Effects

Figure 125. Summary of Effects to Scenic and Recreation Resources.

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)	Alternatives 2	Alternatives 3
Scenic Quality	Visual Quality Objectives Scenic Integrity Level	Very High, High, Moderate, Low, or Very Low	MODERATE to HIGH; within Forest Plan Standards and Guidelines	49 Units and 16 partial units in High 50 units and 29 partial units in Moderate 28 units and 10 partial units in Low	49 Units and 16 partial units in High 50 units and 29 partial units in Moderate 28 units and 10 partial units in Low
Recreational Access	Recreational access to and use of Scaffold Ridge/Oval Peak Trail	Access is open or closed. Trail maintenance occurs or does not occur.	Non-motorized access only. Motorized access closed because of bridge damage; trail maintenance is not occurring due to lack of motorized access.	Open for motorized and non-motorized recreational access pending bridge repair. Trail maintained after motorized access is restored.	Unmaintained route open for stock access. No further trail maintenance would occur.

Alternatives 2 and 3 would protect and maintain the values of scenery and recreation in the Black Pine Lake area. Activities would be designed to blend with the natural terrain in the foreground, and middle ground of the scenic view shed and as time passes, the treatments mosaic patterns will be less noticeable.

Recreational access to the Scaffold Ridge trail and trail maintenance will be reinstated or maintained in Alternative 2 once bridge repair was completed, whereas Alternative 3 would only allow stock access to the trailhead and trail maintenance would cease. Alternative 3 may have a minor impact of the amount of recreational use in the project area.

Temporary closures and disturbances of the groomed snowmobile routes will take place during treatment activities, but no long-term changes to the groomed snowmobile routes will occur.

Temporary closures of road access due to culvert replacements will occur, but only be of a short term duration.

3.12.5 Consistency Statement

The project would comply with all applicable Forest Plan standards and guidelines, as described below.

Forest-wide Standard &Guideline 10-1: Management activities shall be designed to blend, to the extent practicable, with the natural terrain to achieve aesthetics or other resource objectives consistent with the visual quality objectives for the Management Area. Overall, the project would meet a High scenic integrity objective and Retention visual quality objective in the viewshed foreground.

MA4-8A – The visual quality objective is retention. Alternative 2 and 3 would meet the visual quality objective of retention.

MA4-8B – Semi-primitive non-motorized recreation opportunities shall be provided during summer and fall seasons. Semi-primitive motorized recreation opportunities should be provided during winter and spring seasons, but may be restricted to designated routes or areas. Alternative 3, if mitigated for trail access on the 4300-550 and 4300-560 roads would create no long term loss of recreational opportunities.

MA5-8A - The visual quality objective is retention. Alternatives 2 and 3 would meet the established visual quality objective of Retention along the foreground of Black Pine Lake and the Buttermilk Creek (4300) road corridor.

MA5-8B – The visual quality objective is partial retention. Overall, the rest of the project area would meet a range of Visual Quality Objectives from Retention to Partial Retention to Modification.

MA5-8C – Roaded natural recreation opportunities shall be provided. Alternative 2 and 3 would create only short term closures to Forest Service Roads #43, 4340, 4300-300, and the 4300-400 for snowmobiling during harvest activities. No long term loss of recreational opportunities are anticipated.

3.13 Air Quality

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Air Quality Resources Report by M. Trebon (2016), available in the project record. Reference information is contained in the full specialist report.

3.13.1 Methodology

Air quality resources will use the resource indicator and measures are displayed in **Figure 126**.

Figure 126. Air Quality Resource Indicators and Measures

Resource Element	Resource Indicator	Measure (Quantify if possible)	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Air quality impacts	Particulate matter emissions	Particulate matter at 2.5 microns, measured as micrograms per cubic meter µg/m^3 (PM2.5)	Key issue: Prescribed burning will negatively affect air quality.	USEPA 2016
		Particulate matter at 10 microns, measured as micrograms per cubic meter µg/m^3 (PM210)		

Resource Indicator: Particulate Matter at 2.5 microns and 10 microns

This analysis will consider the impacts of prescribed burning on airsheds within and near the project area that are most likely to be affected by PM, including nearby Class I airsheds (**Figure 127**). For the discussion of current air quality, past monitoring data from the air quality monitor closest to the project area (in Twisp, WA, four miles to the northeast of the project boundary) will be used to establish past impacts of sources of PM on air quality. Particulate matter (PM) that would be created by proposed prescribed burning will be determined by modeling expected emissions from proposed prescribed fire treatments with CONSUME 3.0 (Ottmar et al. 2005). Projected fuel loadings created by proposed thinning projects is from selected photo series (Maxwell and Ward 1976; Ottmar et al. 1998). Modeling scenarios use average environmental conditions and expected fuel loading present during four prescribed burning scenarios: underburning (including maintenance burning conducted approximately 10-15 years after the initial prescribed fire treatment), hand-pile burning, machine-pile burning, and landing-pile burning. A detailed description of modeling methods, data, and results are available in the project record.

Figure 127. Airsheds Within and Near Project Area

Airsheds In & Near Project Area	Type of Airshed	Direction from Analysis Area	Distance from Analysis Area
Methow Valley outside of towns	Populated Area	Within & adjacent	Within & adjacent
Carlton	Town	East	1 mile
Methow	Town	Southeast	7 miles
Pateros	Town	Southeast	13 miles
Twisp	Town	East	4 miles
Winthrop	Town	North	11 miles
North Cascades National Park	Class I	Northwest	16 miles
Glacier Peak Wilderness	Class I	West	7 miles
Pasayten Wilderness	Class I	North	24 miles
Lake Chelan-Sawtooth Wilderness	Class II	Within & adjacent	Within & adjacent

3.13.2 Intensity Level Definitions

Type of Impact:

- Adverse: Increases emissions or raises potential pollutant concentrations
- Beneficial: Reduces emissions or lowers potential pollutant concentrations

Duration of Impact:

- Short-term: For prescribed fires, the length of time it takes for smoke to dissipate from a single prescribed burn in the project area (up to three days); for wildfires, the length of time it takes for smoke to dissipate from uncontrolled burning in the project area during periods of inadequate ventilation (up to two weeks).
- Long-term: Time periods longer than three consecutive days (for prescribed burning) or two weeks (for wildfires).

Intensity of Impact:

- None: No impacts
- Negligible: Particulate matter production occurs and smoke is visible, but does not affect sensitive groups or the general public as defined by Washington Department of Ecology (WA DOE 2013b) or the general public; or reduction in wildfire burned area as a result of previous treatments is less than 50 acres.
- Minor: Particulate matter production may cause air quality to be moderate (ibid); or reduction in wildfire burned area as a result of previous treatments is less than 51-250 acres.
- Moderate: Particulate matter production may cause air quality to be unhealthy for sensitive groups; or reduction in wildfire burned area as a result of previous treatments is 251-1000 acres.
- Major: Particulate matter production may cause air quality to be unhealthy to very unhealthy for sensitive groups (ibid) and the general public; or reduction in wildfire burned area as a result of previous treatments is greater than 1000 acres.

3.13.3 Affected Environment

This analysis addresses the issue of potential air quality impacts from actions proposed by this project. Air quality impacts are generally short-lived, and at the time of this analysis, the Twisp monitor did not show any PM2.5 and PM10 concentrations (August 2016). Levels of these criteria pollutants do not currently violate primary or secondary NAAQS. Given the transitory nature of air quality impacts and the current lack of particulate matter, the affected air quality environment will be described further using anecdotal evidence and past monitoring. **Figure 128** displays the current levels of PM2.5 and PM10 for the existing condition.

Figure 128. Air Quality Resource Indicators and Measures for the Existing Condition

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
Air quality impacts	Particulate Matter emissions	Tons of Particulate matter at 2.5 microns (PM2.5)	0

		Tons of Particulate matter at 10 microns (PM10)	0

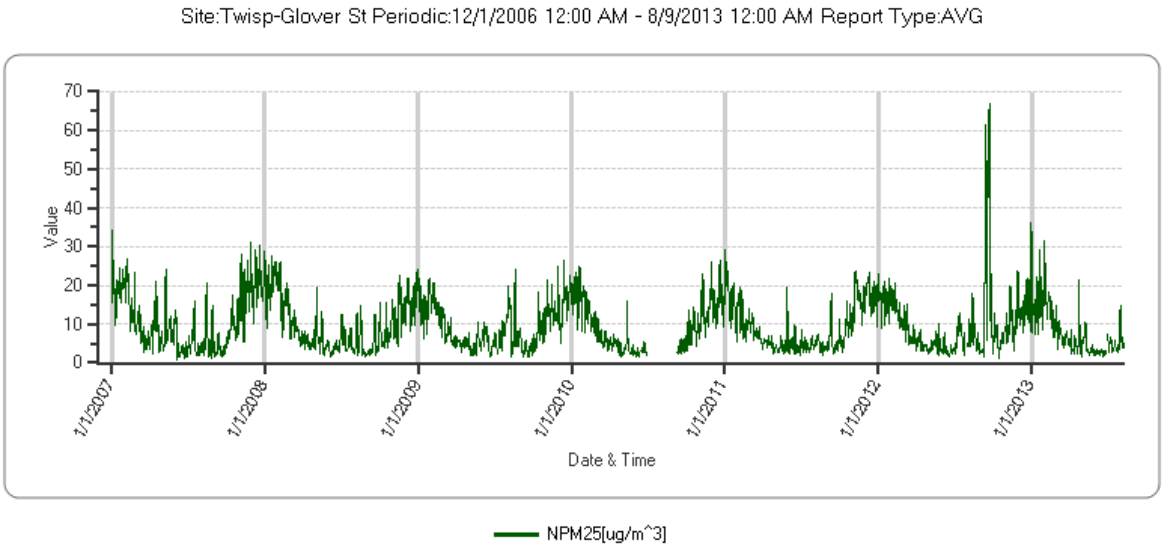
Resource Indicator: Particulate Matter emissions
PM emissions from wildfires have degraded air quality even before European settlement in the Methow Valley in the late 1800s. Natural and human-caused fire regularly created smoke that limited visibility and introduced pollutants into the air (USDA 1997). Panoramic photographs taken from various peaks around the Methow Valley, Pasayten Wilderness, and Okanogan Valley in the 1920s show landscapes obscured by haze. Records from local lookout towers over past decades describe multiple occasions when smoke from local and distant wildfires frequently settled into the airsheds around the project area for long periods of time. This anecdotal evidence supports the likelihood that wildfires have caused long-term, adverse, negligible to major impacts on air quality.

Smoke levels and resulting PM declined across the Columbia Basin as fire was excluded from forests, particularly after the start of organized fire suppression in the 1930s (ibid). In the past 25 years, however, PM emissions have increased as wildfires burned more frequently over larger areas for longer periods across the Western United States and Canada. The 1994 wildfires near Wenatchee, Washington, for example, produced 24-hour concentrations of PM that exceeded federal health standards by twice the limit and lasted for several days (ibid). Anecdotal evidence indicates that the 2003 Farewell Fire and 2006 Tripod Fire in the Methow Valley produced air quality problems for residents of the Okanogan and Methow valleys similar to those experienced in 1994. Wildfires in Eastern Washington during September 2012 adversely affected air quality in the interior Columbia River basin by producing smoke that created hazardous air quality conditions for more than eight days (WA DOE 2012). Routine inversions in Eastern Washington increase the impact of smoke on ambient air quality during these wildfire events. PM emissions are projected to increase as wildfire season lengthens (Westerling et al. 2006; Liu et al. 2010; Climate Central 2012; Jolly et al. 2015).

Air quality impacts from prescribed burning are generally negligible because they are short-term and produce low quantities of PM compared to wildfires. **Figure 129** shows monthly average PM2.5 levels in Twisp, WA as recorded by the Washington State Department of Ecology air quality monitor from 2006-2013. Short-term spikes in PM2.5 occurred occasionally when prescribed burning was conducted (roughly April to early June and October to early November). Higher levels of PM2.5 concentrations lasted for longer periods in fall and winter months, likely caused by smoke from local wood-burning stoves during periods of stagnant air. Spikes in PM2.5 occurring during summer months correspond with heavy wildfire activity in the Methow and Okanogan Valleys and beyond, including Canada. The only reading on this chart that exceeded the NAAQS for PM2.5 happened when the 24-hour average levels of PM2.5 exceeded 35 µg/m3 in late summer/fall of 2012. These emissions were caused by local wildfires in the Methow Valley area that emitted uncontrolled amounts of smoke, followed by periods of stagnant air. As wildfires were brought under control, fuels burned out, and air movement increased, levels of PM2.5 dropped off sharply. Episodes like these demonstrate that wildfires have more potential than any other air pollution source in the country for rapidly exposing the

public to extremely high short-term PM2.5 fine particulate concentrations (Ottmar, personal communication).

Figure 129. Monthly Average PM2.5 Levels in Twisp from December 2006 through July 2013



3.13.4 Environmental Consequences

3.13.4.1 Considered, but not Analyzed in Detail

The following proposed actions will not be considered further in this analysis because they would have no measurable effect on air quality: thinning; soil restoration; opening, closing, or decommissioning roads; rock armoring; replacing undersized culverts or installing fish culverts; beaver habitat or coarse woody debris enhancement; or creating hardened fords.

3.13.4.2 Alternative 1

3.13.4.2.1 Effects

If proposed prescribed fire treatments did not occur, the airsheds in and around the project area would not be affected by emissions from prescribed fire treatments originating in the project area. Nearby prescribed fire treatments would create short-term, adverse, negligible impacts on air quality, while wildfires in and near the project area would produce smoke that created short-term to long-term, adverse, negligible to moderate impacts on air quality depending on the amount of PM produced, current air quality, and existing ventilation conditions. Without proposed thinning and fuel reduction treatments, there would be no opportunities to reduce smoke quantity and limit the volume of smoke created by wildfires. As surface, ladder, and canopy fuel loads continue to increase over time in the project area, fires would likely burn more intensely, with more fuel consumption, longer smoldering, and higher levels of pollutants expelled into the air (Ottmar, personal communication). Increased smoke production burning during common summertime inversions would increase the likelihood of creating a longer-lasting impact on air quality and a higher chance of negatively impacting human health and visibility.

3.13.4.3 Alternatives 2 and 3

Prescribed fire activities proposed in this project are identical in Alternatives 2 and 3, therefore the effects for both alternatives will be described together.

3.13.4.3.1 Effects

Figure 130. Air Quality Resource Indicators and Measures for Alternatives 2 and 3

Resource Element	Resource Indicator (Quantify if possible)	Measure (Quantify if possible)	Alternatives 2 and 3
Air Quality	Particulate Matter	Tons of Particulate matter at 2.5 microns (PM2.5/)	2079 tons
		Tons of Particulate matter at 10 microns (PM10)	2243 tons

Resource Indicator: Particulate Matter

Figure 130 summarizes PM that would be created by proposed prescribed burning activities in Alternatives 2 and 3. Prescribed burning would cause short-term, adverse, negligible to minor impacts on air quality and human health because the PM it produces may affect air quality for sensitive individuals and the general public, as well as visibility (USEPA 2008). Prescribed fire treatments would help create long-term, beneficial, negligible to moderate impacts on air quality because by reducing fire severity in treated areas, less vegetation would be consumed and contribute to PM production during wildfires (Schaaf 1996). Recent thinning and prescribed fire treatments elsewhere on the district helped limit air quality impacts caused by wildfires because they reduced fuel loading and created safer direct suppression opportunities, thereby reducing fire intensity, fire growth, and related PM emissions in some areas of the Tripod, Leecher Mtn, Carlton Complex, Little Bridge Creek, and Twisp River wildfires. (Trebon 2006; Trebon & Johnson 2014). Given the frequent occurrence of ignition through lightning alone, the environmental conditions that annually support wildfire spread, and the availability of fuels to burn, future wildfires in and around the project area are certain. Wildfires generally produce two to four times more smoke per acre than prescribed fires because of drier weather and higher fuel consumption during the less-efficient smoldering stage, with no way to control where the smoke goes or when it will occur. Smoldering that occurs during wildfires produces about twice as much PM10 and PM2.5 when compared to a prescribed fire (NWCG 2001; Ottmar, personal communication).

While smoke from neither prescribed fire nor wildfire is good for humans, prescribed fires proposed in this project would provide opportunities to reduce the volume of PM produced and control the direction and timing of smoke flow. Prescribed fire prescriptions would require conditions when fuels would be consumed more efficiently and produce less smoke. In applying prescribed fire, the dry forest landscape in the project area would act more like its historical fire-adapted ecosystem. The potential release of emissions during any wildland fire in the project area would be substantially reduced following implementation of the prescribed fire treatments described in the proposed action. Mechanical and prescribed fire fuels treatments would reduce

fuels and reduce the likelihood of high-severity fires in treatment areas, allowing for opportunities to control fires at smaller size and minimizing long-term air quality impacts. PM10 production from wildfires would be reduced considerably where prescribed fire treatments are applied. Prescribed fires would be planned for periods when smoke would disperse quickly and avoid sensitive airsheds, further reducing their impacts on air quality in comparison to wildfires that create unpredictable volumes of PM during periods of stagnant air movement.

The design criterion above would help limit human health and visibility impacts from PM and help ensure that PM production does not exceed NAAQS. These criterion would provide for public notification of potential impacts and actions to take to limit exposure. PM production during any single ignition would be restricted by the acres burned, which depends on fuel and ventilation conditions inherent number of personnel available and funding. Local experience shows that ground crews can generally ignite up to 150 acres per day by hand, while aerial ignition accomplishes about 200 to 650 acres per day. Average yearly funding for prescribed fire activities generally allows for up to 1500 acres per year of underburning and 800 acres of pile burning, which is generally spread over multiple areas on the district. PM emissions created by this project would be dispersed over several days during each spring and fall burn season (generally April – early June and mid-September – early November) over about 15 years, with time allowed for smoke dispersal between completion of one underburn project and initiation of the next one.

Smoke drifting towards populated areas with no indications of atmospheric mixing would trigger mitigation measures such as terminating or reducing ignition in that area until atmospheric mixing improved. These measures have been used successfully on the Methow Valley Ranger District over the past fifteen or more years of prescribed burning and are moderately to highly effective in reducing potential impacts to air quality.

Figure 131 displays the amounts of PM2.5 and PM10 that would be created by each type of prescribed fire treatment. Modeling over-predicts emissions for underburns because it assumes a uniform fuel loading across the entire unit and that units are fully blackened; however, fuel loading varies across units and underburning usually creates a mosaic of about 75% burned and 25% unburned areas on average within the unit boundary. In 7,283 acres of underburn treatment units outside of Variable Retention Thinning units, the initial prescribed fire treatment would be followed up in approximately 10-12 years with a maintenance underburn that would create less PM than the initial prescribed fire treatment because the fuel loading during this treatment would be less than during the original treatment.

Figure 131. Particulate Matter Emissions by Proposed Prescribed Burning by Treatment Type

Treatment	Amount Proposed	Tons PM2.5 per Acre or Landing	Total Tons PM2.5	Tons PM10 per Acre or Landing	Total Tons PM10
Underburn (Initial treatment)	7363 acres	0.22	1620	0.24	1767
Underburn (Maintenance treatment)	7283 acres	.05	364	.05	364

Treatment	Amount Proposed	Tons PM2.5 per Acre or Landing	Total Tons PM2.5	Tons PM10 per Acre or Landing	Total Tons PM10
Burn hand piles	2848 acres	0.01	29	0.01	29
Burn machine piles	757 acres	0.02	15	0.03	23
Burn landing piles	187 landings	0.27	51	0.32	60
		Total:	*2079 tons*		*2243 tons*

Effects on Class I Airsheds

Prescribed burning may have short-term, negligible, adverse impacts on the nearest Class I airsheds (the Pasayten or Glacier Peak Wildernesses or North Cascades National Park), but these impacts would be limited because of the distance between these areas and proposed burn units in this project. Ignitions would be planned for times when upper-atmospheric ventilation conditions would be able to dissipate and mix smoke created by prescribed burning in this project. Impacts to Class I airsheds would further be limited by regulations in the SIP. Class II airsheds such as the Lake Chelan-Sawtooth Wilderness have the same regulatory requirements for protection as airsheds outside of wilderness.

3.13.4.3.2 Cumulative Effects

Spatial and Temporal Context for Effects Analysis

The spatial boundary for cumulative effects on air quality is defined by the airsheds listed in **Figure 127** because these are the areas where PM produced by prescribed burning proposed in this project is most likely to affect air quality and visibility. The temporal boundary for cumulative effects on air quality is three days, the amount of time it takes for the majority of smoke from a prescribed burn activity to fully dissipate during and after ignition on the first day, with potential overnight settling the one to two nights after ignition.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

There are no adverse impacts from past or current prescribed burning activities or burning done by the general public (woodstoves and debris piles) within the Methow Valley drainage at the time of this analysis. Planned prescribed fire activities that will affect air quality in the airsheds listed in **Figure 127** include prescribed burning planned on National Forest lands north and west of Winthrop, WA and east of Twisp, WA; and on nearby state and federal lands managed by other entities, along with burning conducted by the general public (woodstoves and debris pile burning). The exact amount of PM created by these activities and the cumulative impact of PM is unknown because the timing and extent of prescribed burning conducted by all land management entities and the general public is unknown, but the cumulative impact of these activities is generally short-term, adverse, negligible to minor effects. Any smoke drifting or settling in the Methow Valley area from prescribed burning activities would dissipate completely within one to three days with no lingering evidence, although ongoing smoke production from woodstove use may continue to produce PM.

Resource Indicator: Particulate Matter
The general public may create PM at the same time and place as prescribed fire activities proposed in this project, and the extent may affect the airsheds listed in **Figure 127**. PM created by the general public may be readily detectable and localized, and usually disperses later in the day as temperatures warm. Adverse PM concentrations, when combined with unfavorable ventilation conditions, would cause Forest Service personnel to delay further ignitions until conditions improved. The cumulative impact of PM would be negligible due to implementation of design criteria and mitigation measures and conformance with existing standards and guidelines on proposed prescribed fire activities.

The cumulative effect of past, present, and reasonably foreseeable future actions and the prescribed burning proposed in Alternatives 2 and 3 on air quality would include short-term, adverse, negligible to minor impacts because it produces PM that may affect human health and visibility. Cumulative effects also include long-term, beneficial, negligible to moderate impacts brought because treatments reduced wildfire severity and/or acres burned, thereby limiting PM production.

3.13.4.4 Summary of Effects

The summary of existing conditions and the effects of Alternatives 2 and 3 are displayed in **Figure 132**.

Figure 132. Air Quality Resource Indicators and Measures for All Alternatives

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)	Alternatives 2 and 3
Air quality impacts	Particulate Matter emissions	Tons of Particulate matter at 2.5 microns (PM2.5)	0	2079 tons
		Tons of Particulate matter at 10 microns (PM10)	0	2243 tons

3.13.5 Consistency Statement

Okanogan National Forest Land and Resource Management Plan
Implementing the proposed action would be consistent with the goals, objectives, and standards and guidelines of the Forest Plan as follows:

Forest-wide Standard & Guideline 14-1: Management activities within the Forest shall be planned to maintain air quality at a level adequate for the protection and use of the National Forest resources, and which also meet or exceed the applicable Federal and State standards. Following the state SIP and monitoring air quality before, during, and after ignitions would help meet this standard.

Forest-wide Standard & Guideline 14-2: The Forest shall demonstrate reasonable progress in reducing total suspended particulate (TSP) emissions from prescribed burning by using efficient means of slash disposal (such as hand-piling or machine-piling) wherever feasible. Mastication would occur over approximately 700 acres in one large unit area to break up slash particles

created by ladder fuel reduction treatments, eliminating emissions from prescribed burning in this area. Implementing Alternatives 2 or 3 would be consistent with the goals and objectives, and standards and guidelines of the Forest Plan and Forest Service manual direction applicable to air quality. Prescribed fire treatments would be designed and implemented in a cost-effective manner to comply with the Clean Air Act and the Washington State Smoke Implementation Plan.

Forest Plan Amendment Effects on Substantive Provisions
To meet Purpose and Needs #2, #3, #4 and #6 identified in Chapter 1 of the EA, vegetation management through thinning would reduce deer winter range cover below Okanogan National Forest Land Resource Management Plan Standard and Guidelines MA14-6A and MA26-6A, requiring a project-specific amendment. The 2012 Planning Rule as amended (36 CFR 219) requires consideration of how such an amendment would affect substantive provisions identified in the Planning Rule. With respect to air quality, the following substantive provision would be affected by the proposed amendment:

<u>219.8(a)(2)(i) Air quality.</u>

Thinning as a result of this amendment would have an adverse, short-term, negligible to minor effect on air quality because it would create debris on 746 acres that would be treated by prescribed burning, which would create smoke containing particulate matter (PM2.5 and PM10) that may affect air quality as described in this section. Prescribed burning would primarily include a mix of hand-pile, machine-pile, and underburning, each of which emit different levels of PM. Of these methods, underburning emits the most particulate matter (0.22 tons/acre of PM2.5 and 0.24 tons/acre of PM10). If all 746 acres of thinning debris created by this amendment were underburned, this activity would create 164.1 tons of PM 2.5 and 179 tons of PM10 over a period of several years of prescribed burning. Implementing any single prescribed burn may affect air quality for sensitive individuals and the general public, as well as visibility (USEPA 2008). Prescribed fire treatments on areas treated as a result of this amendment would help create long-term, beneficial, negligible to moderate impacts on air quality because by reducing fire severity in treated areas, less vegetation would be consumed and contribute to PM production during wildfires (Schaaf, 1996). Recent thinning and prescribed fire treatments elsewhere on the district helped limit air quality impacts caused by wildfires because they reduced fuel loading and created safer direct suppression opportunities, thereby reducing fire intensity, fire growth, and related PM emissions in some areas of the Tripod, Leecher Mtn, Carlton Complex, Little Bridge Creek, and Twisp River wildfires. (Trebon 2006, Trebon & Johnson 2014). Given the frequency of ignition by lightning, the environmental conditions that annually support wildfire spread, Wildfires generally produce two to four times more particulate matter per acre than prescribed fires because of drier weather and higher fuel consumption during the less-efficient smoldering stage, with no way to control where the smoke goes or when it will occur. Smoldering that occurs during wildfires produces about twice as much PM10 and PM2.5 when compared to a prescribed fire (NWCG 2001; Ottmar, personal communication, 02/10/2004).

While smoke from neither prescribed fire nor wildfire is good for humans, prescribed fires to treat slash created by this amendment would provide opportunities to reduce the volume of PM

produced and control the direction and timing of smoke flow. Prescribed fire prescriptions would require conditions when fuels would be consumed more efficiently and produce less smoke. In applying prescribed fire, the dry forest landscape in the project area would act more like its historical fire-adapted ecosystem. The potential release of emissions during any wildland fire in the project area would be substantially reduced following implementation of the prescribed fire treatments described in the proposed action. Mechanical and prescribed fire fuels treatments would reduce fuels and reduce the likelihood of high-severity fires in treatment areas, allowing for opportunities to control fires at smaller size and minimizing long-term air quality impacts. PM10 production from wildfires would be reduced considerably where prescribed fire treatments are applied. Prescribed fires would be planned for periods when smoke would disperse quickly and avoid sensitive airsheds, further reducing their impacts on air quality in comparison to wildfires that create unpredictable volumes of PM during periods of stagnant air movement.

The design criterion listed in Figure 6 would help limit human health and visibility impacts from PM created by prescribed fire conducted to treat slash created by the proposed amendment, and would help ensure that PM production does not exceed NAAQS. Smoke drifting towards populated areas with no indications of atmospheric mixing would trigger the mitigation measure described above such as terminating or reducing ignition in that area until atmospheric mixing improved. These measures have been used successfully on the Methow Valley Ranger District over at least the past fifteen years of prescribed burning and are moderately to highly effective in reducing potential impacts to air quality.

Forest Service Manual Direction
Implementing the proposed action would be consistent with Forest Service Manual direction because this analysis integrates air resource management objectives into planning and management activities proposed by the Mission Restoration Project. Prescribed fire projects would be implemented in the most cost-effective manner that provides for the safety of personnel and the public while meeting resource objectives.

3.14 Economics

The section below summarizes existing condition information along with the direct, indirect, and cumulative effects of the Mission Restoration Project, as analyzed in the Mission Restoration Project Economic Resources Report by M. Isaak (2016), available in the project record. Reference information is contained in the full specialist report.

3.14.1 Methodology

Figure 133 displays the resource indicators that have been used to analyze economic effects.

Figure 133. Economic Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMP's, etc.)?
Viability	Costs directly related to the Timber Sale	Dollars	No	None

This analysis is performed by the use of different spreadsheets. These spreadsheets are: LogCost (provides stump to truck costs), HaulCost (provides Hauling costs), PQA (provides a value for saw log and non-saw log products), and TEA-R6 Econ (provides an overall viability of the project).

Data and other information was provided by field personnel, engineers, and the silviculturist to complete the above spreadsheets.

Costs for all projects are approximate and will need to be assessed during the implementation stage of this Environmental Analysis. Timber sale brush disposal treatment plan costs on the Methow Valley Ranger District typically average $110 per acre as part of the timber sale. Essential reforestation collection (SAI-KV) agreement costs typically average $800 per acre of regeneration harvest treatment. These costs are highly variable depending on acres burned, acres planted, acres of slashing for site preparation, site preparation for planting and natural regeneration, fireline construction costs, slash piling, planting and fuels inventories, burning, etc.

Cost Efficiencies: In the case with fuels treatments, whole landscapes are more efficiently treated than smaller blocks because natural fuel breaks or existing roads may be used for control lines and project planning per acre is reduced. When harvest units are not contiguous with natural fuel treatment units, then costs associated with containment are much higher. A typical unit that has a road directly on the burn boundary may require only a fire line to be constructed and manned across one side of the unit if the adjacent stands are planned to have natural fuels treatments, and the whole area can be burned at the same time. Without contiguous landscape treatments containment costs can be two or three times higher, to the point that the timber sale may not have sufficient receipts to pay for the fuels treatment. Layout and implementation costs are also higher as the distance from an open road is increased. Note that portions of stands that are not likely to receive timber harvest treatments may still receive the ladder fuel reduction and underburn treatments, but the cost to implement those treatments may be higher due to steepness and longer distances from open roads.

Non-Timber Sale Project Costs: The proposed action requires a level of investment that may not be possible within current or expected levels of appropriations. In order to be as effective as possible within budget constraints, an implementation plan would be developed that prioritizes treatments. General guidelines have been developed that would be used to guide this prioritization process. The following three types of treatments have been identified as having the highest priority for implementation.

- Areas closest to the wildland-urban interface (WUI) and emergency egress routes.
- Strategically located treatment units, which because of their location would have a relatively greater effect on modifying fire behavior at the landscape scale.
- Treatments that could be implemented with little or no cost, or which generate funds which can be used to pay for other treatments.

The issue of strategic placement and timing of treatments to effect fire behavior at the landscape scale is the most critical of these in terms of budget constraints. As part of the implementation process, further analysis would be performed to identify the most effective sequence of implementation given budget expectations.

Costs for all projects, displayed in **Figure 134** are approximate and will need to be assessed during the implementation stage of this Environmental Analysis.

Figure 134. Potential Non-Timber Sale Project Costs (in millions).

List of Non-Timber Sale Project Costs	Alternative 2	Alternative 3
Plantation Thin, Wetland Thin, and Post & Pole Thin	0.96	0.96
LFR Thin including machine piling	0.02	0.02
Road Closing/ Decommissioning Projects	0.35	0.58
Beaver Habitat Enhancement	0.01	0.01
Rock Armoring	NA	0.12
Culvert upsizing for non-fish passage	0.12	0.12
Culvert upsizing for fish passage	0.64	0.64
Coarse Woody Debris Enhancement	0.01	0.01
Total	**2.11**	**2.46**

3.14.2 Intensity Level Definitions

Type of Impact

- Beneficial: We propose a Timber Sale in which the monetary benefit is greater than the direct costs.
- Adverse: We propose a Timber Sale in which the monetary benefit is less than the direct costs.

Duration of Impact

- Short term: Occurring during the Timber Sale and associated project activities.
- Long term: 5 to 7 years post-project.

Intensity of Impact

- None: No impacts to Timber Sale Costs
- Negligible: Impacts to Timber Sale Costs are less than $10,000 in monetary revenue that can be used to support Non-Timber Sale Projects.
- Minor: Impacts to Timber Sale Costs are between $10,000 and $100,000 in monetary revenue that can be used to support Non-Timber Sale Projects.
- Moderate: Impacts to Timber Sale Costs are between $100,000 and $350,000 in monetary revenue that can be used to support Non-Timber Sale Projects.
- Major: Impacts to Timber Sale Costs are more than $350,000 in momentary revenue that can be used to support Non-Timber Sale Projects.

3.14.3 Affected Environment

The project area has 1,952 acres that have been identified for commercial timber harvest. The primary stand structure within the Project Area is Young Forest Multi- Story. There is approximately 6,300 Thousand Board Feet (MBF), or 12,600 Hundred Cubic Feet (CCF) of

harvestable timber. Without harvest and thinning treatments, these acres at an increased risk for disturbances (wildfires, insects, and disease).

Figure 135. Economic Resource Indicators and Measures for the Existing Condition

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
Viability	Costs directly related to the Timber Sale	Dollars	None (increased risk of loss)

3.14.4 Environmental Consequences

3.14.4.1 Considered, but not Analyzed in Detail

The economic resources were considered but not analyzed in detail are displayed in **Figure 136**. Additional information about the potential impacts to these resources are discussed in the Mission Project Economic Resource Report (Isaak 2016).

Figure 136. Economic Resources Considered But Not Analyzed in Detail

Resource	Examples	Rationale for Dismissing from Further Analysis
Benefits	Potential reduction of future fire suppression costs Protection of non-market resource values, existing market value resources, and prior investments Job creation Cost/benefit ratio and present net value	While the costs of implementing many aspects of the proposed project can be expressed in monetary terms, the benefits are not as easily quantified and involve both market and non-market values.
Non-Timber Sale Costs	Plantation Thin, Wetland Thin, and Post & Pole Thin LFR thinning Road closing/decommissioning (Not along approved haul routes for the Timber Sale) Rock Armoring Beaver habitat enhancement/aquatic habitat improvements Culvert replacement	Funding for the different non timber projects can come from a variety of different sources such as appropriations, stewardship receipts, or through partnerships with public and private collaborates. It is this funding uncertainty that will make it difficult to analyze into depth.

3.14.4.2 Alternative 1

3.14.4.2.1 Effects

Alternative 1 does not include any harvesting or selling Forest Products. The impact of Alternative 1 would be adverse, long-term, and minor because without continued treatments, previous investments and the gains that have been achieved are at an increased risk of loss

through widespread uncharacteristic fire behavior, insects, and disease. Large-scale stand replacement fires, especially in areas where they are not characteristic of the inherent fire regime can cause substantial damage to both private and public resources. As discussed in the fire/fuels analysis, under the No Action Alternative, the area would continue to be at and increasing risk of widespread uncharacteristic fire behavior.

3.14.4.3 Alternatives 2 and 3

There are no differences in the proposed commercial harvest between Alternatives 2 and 3 so the economic effects of the timber sale will be the same and they will be analyzed together. Alternative 3 includes additional road closing/ decommissioning and rock armoring/hardened fords work. Cost estimation from the additional work can be found in **Figure 134** but were not included in this analysis.

3.14.4.3.1 Effects

Alternatives 2 and 3 includes about 1,952 acres of proposed harvest treatments where commercially valuable timber would be removed as a byproduct of that treatment. The value of these marketable products can substantially reduce the overall costs of the project. The impact of Alternatives 2 and 3 would be beneficial, long-term, and moderate because with treatments, monetary benefits can be used to fund restoration activities on the landscape.

Figure 137. Economic Resource Indicators and Measures for the Proposed Action.

Resource Element	Resource Indicator	Measure	Alternatives 2 and 3
Viability	Costs directly related to the Timber Sale	Dollars	$310,000

Ground based equipment could be used to log 1,833 acres and the other 119 acres could be harvested by the use of a standing skyline system. This standing skyline system would be designed to achieve at least one end suspension of the harvested timber. Mobilization and logging costs for the ground based are estimated to be $136/MBF and $223/MBF for the skyline portion of the timber sale.

It is expected that approximately 6,300 MBF (thousand board feet), or 12,600 CCF (hundred cubic feet) would be harvested by ground based and skyline based felling and yarding equipment. June 2016 log prices for delivered Douglas-fir are $380.85/MBF, harvesting 7 to 23.9 inch DBH trees would generate $2.73 million in timber value at the mill. After logging operations including :felling, skidding, processing, loading, required brush disposal, road maintenance, and required mitigation including: rock armoring, erosion control and reforestation (SAI- KV Collection Agreement costs on the planned 80 acres of Variable Retention Regeneration harvest would be an estimated $64,000), there would remain approximately $310,000 that could be used to supplement or support other planned projects.

Some commercial sized trees, up to 14 inches DBH, would be fell in areas inaccessible to logging equipment in order to meet landscape fuel objectives. These trees would not be available for harvest or firewood. Because these steep and/or unroaded area are marginally

suitable for timber management, it is not likely that the removal of these trees from the stands would reduce the future timber value for the project area.

3.14.4.3.2 Cumulative Effects
There are no cumulative effects related to the financial aspects of the project since costs and benefits are shown over a multi-year basis.

Forest Plan Amendment Effects on Substantive Provisions
To meet Purpose and Needs #2, #3, #4 and #6 identified in Chapter 1 of the EA, vegetation management through thinning would reduce deer winter range cover below Okanogan National Forest Land Resource Management Plan Standard and Guidelines MA14-6A and MA26-6A, requiring a project-specific amendment. The 2012 Planning Rule as amended (36 CFR 219) requires consideration of how such an amendment would affect substantive provisions identified in the Planning Rule. With respect to economics, the following substantive provisions would be affected by the proposed amendment:

219.8(b)(1) Social, cultural, and economic conditions; and 219.8 (b) (3) Multiple uses that contribute to local, regional, and national economies in a sustainable manner. Commercial and noncommercial thinning that would occur on 746 acres as a result of this amendment, and associated prescribed fire activities that would treat the slash created by thinning, would have a beneficial, short-term, minor to moderate effect on economic conditions relevant to the area influenced by this project because it would result in local and regional employment opportunities and merchantable timber for processing at regional mills. Since the amendment would affect up to 54 percent of the proposed commercial thinning units, the employment opportunities and volume of timber would be approximately the same percentage of the employment opportunities and volume for all proposed commercial thinning, or 3.4 mbf in volume and 45 FTE jobs. To the extent that thinning provided by this amendment occurs as noncommercial thinning, the timber volume would be reduced and the number of FTE jobs would increase.

3.14.4.4 Summary of Effects
It appears that this Timber Sale would be viable and have a moderate impact that could potentially contribute $310,000 to Non-Timber Sale Projects.

3.15 Other Required Disclosures

3.15.1 Social Groups, Civil Rights, and Environmental Issues
Civil Rights would not be affected by the Mission Restoration project. The project includes timber sale purchaser work, Forest Service contracted work, and Forest Service employee-accomplished work. Under Executive Order 11246 companies with Federal, contracts or subcontracts are prohibited from job discrimination on the basis of race, color, religion, sex, or national origin. The U. S. Department of Agriculture prohibits discrimination in its employment practices based on race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital and family status.

Executive Order 12898 (59 Fed, Reg. 7629, 1994) directs Federal agencies to identify and address, as appropriate, any disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. No minority communities are located adjacent to the planning area. Timber sale haul routes would likely to pass through the small towns of Carlton, Twisp, and Winthrop, which contain low-income communities. Because the route, on Highway 20, receives regular local, tourist and commercial traffic, the effects on traffic and noise would not be noticeable.

The effects of the proposed action on civil rights and low income or minority communities would be minimal. Employment would be created through both timber sale and service contracts, and contractors/subcontractors are prohibited from discrimination based on race, color, religion, sex, or national origin. Some contracts for this project may be offered under Small Business Administration authorities, which could result in positive employment benefits to minority populations.

The proposed action would not have disparate effects on any consumers, minority groups, women, civil rights, or social/ethnic groups. All contracts would meet Equal Employment Opportunity requirements.

3.15.2 Floodplains and Wetlands

No impacts to designated floodplains are projected. Hand-thinning of small conifers is proposed in designated wetlands around Mission Pond and Blackpine Meadows to reduce conifer encroachment with the beneficial impact of sustaining wetland habitat. Project activities would occur in some Riparian Reserves; effects are described in the forest vegetation, water resources, and botany sections of this chapter. Floodplains and wetlands would be protected through project design details and mitigation measures listed in Appendix D, which conform to Executive Orders 11988 and 11990.

3.15.3 Prime Farm, Range and Forest Land

The proposed action complies with the Federal Regulations for prime land. Lands within the project area do not qualify as “prime” forest land. Effects to forestland are described earlier in this chapter. The Mission Restoration analysis area does not contain any prime rangeland or prime farm land, therefore, none of the alternatives would have any effect on prime rangeland and farmland.

3.15.4 Climate Change, Greenhouse Gases and Carbon Sequestration

This proposed action would affect 10,255 acres of forest by thinning smaller trees from the stand, retaining an estimated residual stand of about 70 percent of the original stand by crown cover where understory thinning alone occurred, and 50 – 60 percent of the original stand by crown cover where overstory thinning occurred. This scope and degree of change would be minor relative to the amount of forested land in the Pacific Northwest region as a whole. Climate change is a global phenomenon because major greenhouse gasses (GHG) mix well throughout the planet’s lower atmosphere (IPCC 2013). Considering emissions of GHG in 2010 was estimated at 49 ± 4.5 gigatonnes[1] globally (IPCC 2014) and 6.9 gigatonnes nationally (US EPA,

[1] A gigatonne is one billion metric tons of CO_2; equal to about 2.2 trillion pounds.

2015), a project of this magnitude makes an infinitesimal contribution to overall emissions. Therefore, at the global and national scales, this proposed action's direct and indirect contribution to greenhouse gasses and climate change would be negligible. Because the direct and indirect effects would be negligible, the proposed action's contribution to cumulative effects on global greenhouse gasses and climate change would also be negligible.

The Intergovernmental Panel on Climate Change has summarized the contributions to climate change of global human activity sectors in its Fifth Assessment Report (IPCC 2014). In 2010, anthropogenic (human-caused) contributors to greenhouse gas emissions came from several sectors:

- Industry, transportation, and building – 41%
- Energy production – 35%
- Agriculture – 12%.
- Forestry and other land uses – 12%

There is agreement that the forestry sector contribution has declined over the last decade (IPCC, 2014; Smith et al., 2014; FAOSTAT, 2013). The main activity in this sector associated with GHG emissions is deforestation, which is defined as removal of all trees, most notably the conversion of forest and grassland into agricultural land or developed landscapes (IPCC 2000).

This restoration project does not fall within any of these main contributors of greenhouse gas emissions. Forested land will not be converted into a developed or agricultural condition. In fact, forest stands are being retained and thinned to maintain a vigorous condition that supports trees, and sequesters carbon long-term. US forests sequestered 757.1 megatonnes[2] of carbon dioxide after accounting for emissions from fires and soils in 2010 (US EPA, 2015). However there is growing concern over the impacts of climate change on US forests and their current status as a carbon sink. There is strong evidence of a relationship between increasing temperatures and large tree mortality events in forests of the western US. There is widespread recognition that climate change is increasing the size and frequency of droughts, fires, and insect/disease outbreaks, which will have major effect on these forests' role in the carbon cycle (Joyce et al. 2014).

The project is in line with the suggested practice of reducing forest disturbance effects found in the National Climate Assessment for public and private forests (Joyce et al. 2014). Here specifically, the project proposes to thin forests to maintain or restore vegetation stand structure and growth patterns to increase resistance to insect mortality, wildfire, and drought. The release of carbon associated with this project is justified given the overall change in condition increases forest resistance to release of much greater quantities of carbon from wildfire, drought, insects/disease, or a combination of these disturbance types (Millar et al. 2007). This project falls within the types of options presented by the IPCC for minimizing the impacts of climate change on forest carbon, and represents a potential synergy between adaptation measures and mitigation. Actions such as those proposed in this project that are aimed at enhancing forest

[2] A megatonne is one million metric tons of CO_2; equal to about 2.2 billion pounds.

resilience to climate change by reducing the potential for large-scale, catastrophic disturbances such as wildfire also prevents release of GHG and enhances carbon stocks (Smith et al. 2014). The residual vegetation composition would maintain or increase biomass production over the long-term (i.e. decades).

Timber management projects can influence carbon dioxide sequestration in four main ways: (1) by increasing new forests (afforestation), (2) by avoiding their damage or destruction (avoided deforestation), (3) by manipulating existing forest cover (managed forests), and (4) through transferring carbon from the live biomass to the harvested wood product carbon pool. Land-use changes, specifically deforestation and regrowth, are by far the biggest factors on a global scale in forests' role as sources or sinks of carbon dioxide, respectively (IPCC, Intergovernmental Panel on Climate Change, 2000). Projects like the proposed action that create forests or improve forest conditions and capacity to grow trees are positive factors in carbon sequestration.

3.15.5 Potential Conflicts with Plans or Policies or other Jurisdictions

Actions proposed under this project would occur solely on NFS lands that are under the jurisdiction of the Forest Service. Required consultation with regulatory agencies has occurred or is underway, and would be completed before the project is finalized. Proposed treatments would be consistent with management direction, laws, and policies as described in Chapter 3 and resource specialist reports.

3.15.6 Public Health and Safety

There would be limited health and safety hazards to Forest Service Employees, permittees, and the general public from the project. None are unusual or unique to this project. Recreationists, nearby residents, and permittees could be exposed to smoke during prescribed fire operations. All burning would be done under Washington State Smoke Management Requirements, and would maintain air quality within federal Clean Air Act standards. Proposed treatments would use design criteria, monitoring, and mitigation to maintain Clean Water Act standards. Recreationists and residents could encounter logging traffic. Most logging roads, except main haul routes, will remain closed to the general public to minimize traffic conflicts and impacts to wildlife, and log hauling and heavy equipment moving during weekends and holidays is prohibited, without prior approval from the Forest Service, beginning Memorial Day weekend through Labor Day weekend and also during the general rifle deer hunting season. The safety of the area would be beneficially improved for recreationists and wildland firefighters by the reduction of fuels creating safe escape routes, safer, more direct fire suppression conditions, and an increased ability to protect private homes and structures in the area.

3.15.7 Energy Requirements and Conservation Potential of Alternatives

In relation to national and global petroleum reserves, the energy consumption associated with the proposed action would be minor. Fossil fuels used during the operation and transportation phases of the Mission Restoration project would result in an irreversible resource commitment of fossil fuel resources. Energy consumption associated with this project would be negligible at the local, regional, or national scale.

3.15.8 American Indian Treaty Rights

No American Indian Treaty Rights would be affected by the Mission Restoration Project. The Tribal governments for the Confederated Tribes of the Colville Indian Reservation and the Yakama Nation were contacted during government to government consultation; no concerns about the project were raised by either tribal government.

3.15.9 Wilderness, Inventoried Roadless Areas, and Unroaded Areas

Approximately 10% (15,770 acres) of the Lake Chelan-Sawtooth Wilderness area lies within the southwestern part of the project area. No activities are proposed within the wilderness boundary as part of the Mission Restoration project. Approximately 3% (3300 acres) of the Sawtooth Inventoried Roadless Area (IRA) is located in the southwestern portion of the planning area. Approximately two acres of underburning are proposed in the IRA as part of a larger landscape treatment unit. Approximately 900 feet of hand fireline would be constructed in the IRA as part of this treatment. No trees would be felled and no roads would be constructed in the IRA. Approximately 3% (177 acres) of unroaded area within the project boundary but outside of wilderness would be treated by proposed understory ladder fuel reduction thinning and prescribed fire in Libby Creek, along with two miles of hand fireline. These totals do not include those proposed in the IRA, as those treatments are within one-half mile of an existing road.

Treatments proposed in the IRA and unroaded area are designed to restore desired low ranges of crown fire risk and to reduce wildfire hazards in a priority WUI treatment area as designated by the Community Wildfire Protection Plan. These proposed actions would not degrade the quality of the IRA or unroaded area, or change the potential of these areas to be considered for wilderness designation in the future. The project would have minor impacts on the untrammeled quality of wilderness character in the IRA and unroaded areas, with minor, localized impacts. There would be no impacts to the undeveloped or natural qualities since there would be no roads constructed. There would not be any impacts to the opportunities for solitude or primitive or unconfined recreation because these portions of the project area are not currently offering these opportunities due to their close proximity to private land and open roads.

3.15.11 Wild and Scenic Rivers

There are no designated Wild and Scenic Rivers within or near Mission Restoration Project planning area. The Twisp River is eligible for Wild and Scenic designation approximately two miles upstream from the project boundary, but this area would not be affected by the project.

3.15.12 Heritage Resources

A cultural resource survey was completed in 2016 under supervision of the project archaeologist. The survey met the requirements of Section 106 of the National Historic Preservation Act (NHPA) of 1966 (36 CFR 800). No sites or isolates eligible for the National Register of Historic Places were discovered within proposed treatment areas. The Washington State Department of Archaeology and Historic Preservation concurred with the Determination of "No Historic Properties Affected" on September 29, 2016. All of the alternatives proposed in the Mission Restoration project would comply with federal laws. The Okanogan National Forest Plan tiers to these laws with no additional standards, therefore the proposed action alternatives meet Forest Plan Standards and Guidelines for Cultural Resources (Okanogan Forest Plan,

Pages 4-36 to 4-38). With the completion of the cultural resources inventory per Section 106 of the NHPA and under the terms of the 1997 Programmatic Agreement with Washington SHPO and by providing the interdisciplinary team with appropriate input as per NEPA, all relevant laws and regulations have been met.

3.16 Substantive Provisions Affected by Proposed Amendment

As discussed previously in this EA, the Forest Service has identified a need to amend the 1989 Okanogan Forest Plan to better reflect current conditions and scientific understanding regarding necessary vegetation management within the Mission Restoration project area. Based on the direction provided in 36 CFR 219, the Responsible Official must determine the appropriate scope and scale of forest plan amendments and apply those provisions of 36 CFR 219.8 through 219.11 that directly apply to the proposed amendments. In the following section, the provisions of 36 CFR 219.8 through 219.11 that are affected by thinning on 746 acres of deer winter range cover, as the proposed amendment would allow, are briefly identified and discussed. Effects are further described in resource sections referenced after each provision.

219.8(a)(1)(ii) Contributions of the plan area to ecological conditions within the broader landscape influenced by the plan area. Thinning would have beneficial, short- to long-term, minor to moderate effects on ecological conditions within the broader landscape because it would open up the forest canopy and result in an increase in forage available to mule deer and other animals, which would contribute to the sustainability of migratory mule deer populations present in the greater Methow Valley (Revised Preliminary EA at p. 211).

219.8 (a)(1)(iv) System drivers such as wildland fire, invasive species, and climate change, and the ability of terrestrial and aquatic ecosystems in the plan area to adapt to change; (v) Wildland fire and opportunities to restore fire-adapted ecosystems; and (vi) Opportunities for landscape scale restoration. Thinning would create an adverse, short-term, negligible effect on system drivers such as invasive species because thinning would create a more open forest canopy, allowing more light to reach the surface and providing favorable conditions for the spread of invasive species (Revised Preliminary EA at p. 276).

Thinning would have beneficial, short to long-term, minor to moderate effect on wildland fire, climate change, and the ability of terrestrial and aquatic ecosystems to adapt to change because it would create forest vegetation structure, overstory and understory species composition, and spatial patterns that are more likely to experience low-severity fire behavior and are more similar to historical and predicted future conditions. These conditions would be less vulnerable to effects of climate change such as increased warming and drying during the summer months (Revised Preliminary EA at p.132, 168).

219.8(a)(2)(i) Air quality. Thinning would have an adverse, short-term, negligible to minor effect on air quality because it would create slash that would be treated by prescribed burning, which would create particulate matter. Thinning would also contribute to a beneficial, long-term, negligible to moderate effect on air quality because thinning and associated prescribed fire treatments would reduce the likelihood of high fire severity during wildfires, resulting in less

vegetation consumed and less particulate matter produced (Revised Preliminary EA at p. 296-297).

219.8(a)(2)(ii) Soils and soil productivity. Thinning would have adverse, short-term, minor effect on soils because equipment used during commercial thinning operations, would cause soil compaction and displacement on some areas thinned under this amendment. Thinning would also create beneficial, long-term, moderate effects on soil productivity because it would leave a variety of organic matter on the site that would help maintain site productivity, protect the soil surface from raindrop impact, dissipate energy of overland flow, bind soil particles together, and dampen soil temperature extremes and daily fluxes. (Revised Preliminary EA at p. 98-99).

219.8(a)(2)(iii) Water quality. Thinning as provided by the amendment would have an adverse, short-term, negligible impact on water quality because some thinning would result in commercial haul on forest roads that may contribute sediment to streams and impact water quality. Thinning would also contribute to beneficial, short to long-term, minor to moderate effects on water quality because thinning and associated prescribed fire treatments would develop forest vegetation structure, overstory and understory species composition, and spatial patterns that are more likely to withstand insect and disease outbreaks and would be more likely to experience low-severity wildfire behavior and effects with reduced impacts to water quality (Revised Preliminary EA at p. 79-80).

219.8(a)(3) Riparian areas. Thinning as provided by the amendment would have beneficial, short- to long-term, minor to moderate effects on streams because thinning in some areas would promote hardwoods, providing more suitable beaver food and habitat and increasing opportunities for successful beaver re-introduction as conducted by Washington State Department of Fish and Wildlife (WA DFW). Successful beaver reintroduction would promote water storage and longer stream flow (Revised Preliminary EA at p. 80).

219.8(b)(1) Social, cultural, and economic conditions. Thinning as provided by the amendment would have beneficial, short-term, minor to moderate effects on social conditions by reducing fire hazards in the wildland urban interface (WUI) and along major access routes in the project area (FS Roads 43 and 4340). These actions would reduce risk from wildfires and provide more suppression opportunities, contributing to increased sustainability of local communities in the WUI (Revised Preliminary EA at p. 168).Thinning would also contribute to a beneficial, short-term, minor effect on economic conditions because thinning and prescribed burning would provide employment opportunities and merchantable timber for processing at regional mills (Revised Preliminary EA at p. 302).

219.8(b)(3) Multiple uses that contribute to local, regional, and national economies in a sustainable manner. Thinning as provided by the amendment would have a beneficial, long-term, moderate effect on range because thinning in deer winter range cover would promote more open stand structure and increase in forage that would be available as transitory range (Revised Preliminary EA at p. 258).Thinning would also contribute to a beneficial, short-term, minor effect on multiple uses that contribute to local, regional, and national economies in a sustainable manner because, as mentioned above, thinning would provide employment

opportunities and merchantable timber for processing at regional mills (Revised Preliminary EA at p. 302).

219.9(a)(1) Ecosystem integrity. Thinning as provided by the amendment would have a beneficial, short- to long-term, minor to moderate effect on terrestrial ecosystems because thinning and associated prescribe fire treatments in deer winter range cover would contribute to the sustainability of thermal cover and other vegetation on the landscape by promoting low-intensity wildfire behavior with less canopy fire. Treatments would maintain and restore stand structure, composition, and arrangement that would be less susceptible to stand-replacing wildfires that could extensively damage and reduce vegetation (including thermal cover) on the landscape (Revised Preliminary EA at p. 211-212).

Thinning would also have a beneficial, short to long-term, minor to moderate effect on terrestrial ecosystems by creating forest vegetation structure, overstory and understory species composition, and spatial patterns similar to historic conditions. In doing so, thinning would help maintain or restore ecosystem characteristics similar to historical conditions that are more conducive to low-severity wildfire and less vulnerable to insect and disease outbreak, which would help maintain the desired ecosystem on the landscape to maintain the sustainability of the landscape (Revised Preliminary EA at p. 132-133).

219.9(a)(2)(i) Key characteristics associated with terrestrial and aquatic ecosystem types. Thinning as provided by the amendment would have an adverse, short-term, negligible impact on key characteristics associated with aquatic ecosystems because, as discussed in 219.8(a)(2)(iii), it would result in some commercial haul on forest roads that may contribute sediment to streams and impact water quality. Thinning would also have a beneficial, long-term, minor to moderate effects on water quality, a key characteristics associated with aquatic ecosystems, because thinning and associated prescribed fire treatments would develop forest vegetation structure, overstory and understory species composition, and spatial patterns that are more likely to withstand insect and disease outbreaks and would be more likely to experience low-severity wildfire behavior and effects with reduced impacts to water quality. (Revised Preliminary EA at p. 79-80).

Thinning would have beneficial, long-term, moderate effects on key characteristics associated with terrestrial ecosystem types by increasing community heterogeneity and species diversity (Revised Preliminary EA at p. 237).

Thinning would have an adverse, minor, long-term effect on snag habitat used by cavity excavators and other species due to minor loss of snags that are felled as hazard trees in units. This would be countered by a beneficial, long-term, minor effect on snag habitat as thinning would contribute to acceleration of growth of large trees which will become large snags. Thinning would also have a beneficial, short-term, minor effect on forage available for mule deer by opening up the tree canopy and allowing more sunlight and precipitation to reach the ground, resulting in more vegetation that provides more browse for deer. Increases in forage levels contribute to greater chance for winter survival. With respect to habitat connectivity, thinning would cause forested stands to be more open as a result of thinning, resulting in an adverse, short- to medium-term, minor effect on connectivity for species that prefer more closed habitat,

and a beneficial, short- to medium-term, minor effect on connectivity for species that prefer more open habitat. (Revised Preliminary EA at p. 212).

219.9(a)(2)(iii) Diversity of native tree species. Thinning would have a beneficial, long-term, moderate effect on the diversity of native tree species because it would promote aspen health and vigor by removing competing conifer encroachment that suppresses aspen sprouts and overtops and kills the aspen overstory though vegetative competition for lights and soil resources (Shepperd et al., 2001a; Jones et al., 2005) (Revised Preliminary EA at p. 237-238).

219.9(b)(1) Additional species-specific plan components.

The following Threatened or Endangered species are present and/or have habitat in the project area; the effects described apply only to the thinning that would occur as a result of the amendment:

Wolves and grizzly bear: Thinning would cause an adverse, short-term, negligible effect because thinning may temporarily displace prey species (deer) and reduce cover for prey species in some areas, although adequate cover would remain. Thinning would not degrade habitat for these species. Thinning would cause a beneficial, short- to long-term, minor effect to grizzly bears because thinning would open up forested stands and encourage growth of forage for prey species (deer) (Revised Preliminary EA at p. 212).

Northern spotted owl: Of the nesting, roosting, and foraging (NRF) habitat that lies within deer winter range cover, 203 acres would be slightly degraded by noncommercial treatment and 27 acres would be slightly degraded by commercial thinning. Thinning would cause an adverse, short- to medium-term, minor effects on suitable NRF habitat because thinning would degrade habitat by reducing canopy cover. Thinning would cause beneficial, long-term, moderate effects for NRF because thinning and associated prescribed fire activities would develop forest vegetation structure, overstory and understory species composition, and spatial patterns that are more likely to withstand insect and disease outbreaks and would be more likely to experience low-severity wildfire behavior and effects with reduced impacts to these species and their habitat. In addition, thinning would promote habitat with large trees suitable for spotted owl. (Revised Preliminary EA at p. 213).

Critical Habitat for Lynx: Beneficial, short to medium-term, minor effect on critical habitat for lynx because thinning would reduce forested stand density and encourage growth of forage for prey species (snowshoe hare) (Revised Preliminary EA at p. 213).

Spring Chinook, summer steelhead, and bull trout: Thinning as allowed by the amendment would have an adverse, short-term, negligible effect on habitat for these species because log haul traffic associated with commercial thinning would cross streams on roads and contribute some sediment to streams. Thinning would have beneficial, short- to long-term, minor to moderate effects on habitat used by these species because thinning and associated prescribed fire treatments would develop forest vegetation structure, overstory and understory species composition, and spatial patterns that are more likely to withstand insect and disease outbreaks and would be more likely to experience low-severity wildfire behavior and effects with reduced impacts to these habitats (Revised Preliminary EA at p.80).

The following Region 6 Regional Forester Sensitive Species are present in the Mission project area:

Gray flycatcher: Thinning would cause an adverse, short-term, minor effect on habitat because of disturbance from thinning activities, a temporary increase in open road density, and minor shrub loss. Thinning would create a beneficial, long-term, moderate effect on habitat for this species because thinning would contribute to increased availability and quality of shrub habitat (Revised Preliminary EA at p.213).

White-headed woodpecker: Thinning would cause an adverse, short to long-term, minor effect on snag habitat because some snags that are considered hazardous trees would be felled during commercial thinning operations; and beneficial, long-term, minor effects on snag habitat because post-thinning prescribed fire operations would create snags, and thinning would contribute to the growth of larger trees that would eventually become larger snags. (Revised Preliminary EA at p. 213-214).

Western gray squirrel: Thinning would cause an adverse, short-term, minor effect on habitat because thinning would reduce arboreal travel opportunities or nests; vehicle traffic associated with activities increate the potential for mortality; and fungi foods would be less abundant; and a beneficial, long-term, minor effects because thinning would increase food resources, and, along with associated prescribed fire treatments, would help protect habitat from effects of uncharacteristic wildfire. (Revised Preliminary EA at p.214).

Northern Goshawk: Thinning would cause adverse, short- to long-term, minor effects on habitat because thinning would reduce canopy closure, thereby reducing suitable nesting habitat; and would result in the loss of some prey that use snags that may be felled as hazard trees. Thinning would cause beneficial, short- to long-term, minor effects on habitat because thinning would create more open stands with more diverse vegetation structure, with an increase in prey availability and diversity. Noncommercial thinning in the understory tree layer would reduce understory density and reduce the risk of wildfire and insect activity which could destroy nests and post-fledgling areas. Thinning would also accelerate growth of larger trees used for habitat. (Revised Preliminary EA at p.214).

West-slope cutthroat and interior redband rainbow trout: Thinning as allowed by the amendment would have an adverse, short-term, negligible effect on habitat for these species because log haul traffic associated with commercial thinning would cross streams on roads and contribute sediment to streams. Thinning would have beneficial, short- to long-term, minor to moderate effects on habitat used by these species because thinning and associated prescribed fire treatments would develop forest vegetation structure, overstory and understory species composition, and spatial patterns that are more likely to withstand insect and disease outbreaks and would be more likely to experience low-severity wildfire behavior and effects with reduced impacts to these habitats. (Revised Preliminary EA at p.80).

Chapter 4: List of Agencies and Persons Consulted

The Forest Service consulted the following individuals, Federal, state and local agencies and tribes during the development of this environmental assessment. Details regarding public involvement and collaboration are included in Chapter 1 of this document.

4.1 Agencies

U.S. Fish and Wildlife Service
National Oceanic and Atmospheric Administration – National Marine Fisheries Service
Washington State Historic Preservation Office
Washington State Natural Heritage Program
Washington Department of Fish and Wildlife
Washington Department of Natural Resources

4.2 Tribes and Local Government

Confederated Tribes of the Colville Reservation
Yakama Nation
Okanogan County Commissioners

4.3 Individuals that Commented

Note: the following list contains names of those who commented during the scoping period. The final EA will contain the list of those who commented during the 30-day comment periods following the release of the preliminary and revised preliminary EAs.

Marjorie Barker
Gus Bekker, El Sendero Backcountry Ski and Snowshoe Club
Denise Boggs, Conservation Congress
Ronda Bradeen
Clare Bresnahan
Donna (Pema) Bresnahan, Libby Creek Watershed Association
Theresa Casagram
Paul Christen
Jon Christiansen
Miranda Christiansen

Derek Churchill
Lee Cobert
Maggie Coon, Methow Valley Citizens Council
Joanne Cooper
Kitty Craig, The Wilderness Society
Susan Crampton
Surya DiModica
William DiModica
Steve Dixon
Ted E. Bear
Andy Floyd
Chris Frue
Michael Garrity, Alliance for the Wild Rockies
David Gottlieb
Nava Gross
Laura Gunnip
Daniel H Russell
Holly Hall
Jim Hammer
Tom Hammond, North Cascades Conservation Council
Julie Hentrich
Steve Hirsch
Kathleen Hirschstein
Katherine Hollis, The Mountaineers
Dave Hopkins and Susan Spier
Andrea Imler, Washington Trails Association
Laird J. Lucas, Advocates for the West
Don Johnson
Julie Johnson
Pat Jones
Jeff Juel, Sierra Club Upper Columbia River Group
Todd Kammers
Daniel Kirkpatrick
Yvonne Kraus, Evergreen Mountain Bike Alliance
Carla Lange
Peter Morrison, Craig Olson and Stephen Ralph, Pacific Biodiversity
Judy Northcott-Walters
David Notter
Patricia Notter
Tom Partin, American Forest Resource Council
Terry Rabourn
Bob Rivard, Buttermilk Firewise Community
Harry Romberg, Washington Chapter of the Sierra Club
Barry Rosenberg

Paul Ruprecht, Western Watershed Project
Eve Russell
Patricia Sloan
Tom Stahl and Patricia Michl
Lindsey Swope, Emma Liles, and Victor Liles, Skalitude Retreat
Dave and Ann Tate
Robert Thomas
Bernard & Diane Thurlow
Tom Uniak, Washington Wild
Unknown (illegible)
Lynx Vilden
Betty Wagoner
Bryan Ward
Paul Ward and Lloyd McGee, North Central Washington Forest Health Collaborative
Jen Watkins and George Wooten, Conservation Northwest
Ken Willis
Marlies Wirerenga, WildEarth Guardians